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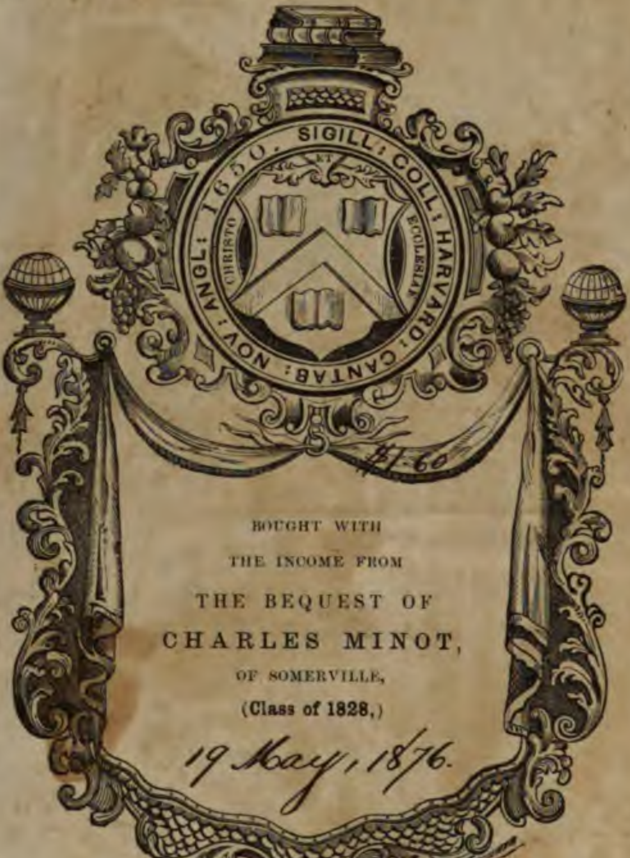
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OF

SCIENCE AND INDUSTRY

FOR 1875.

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SPENCER F. BAIRD,

WITH THE ASSISTANCE OF EMINENT MEN OF SCIENCE.

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PREFACE.

In presenting to the public the fifth volume of the series of the "Annual Record of Science and Industry," a few words in explanation appear to be called for.

In each of the successive numbers already published, new features have been introduced, suggested by experience as well as by the advice of the scientific collaborators and friends of the editor.* These are exemplified in part by the increasing number of communications and criticisms on progress in the various branches of science, and by the greater extent of historical résumés given under the caption of "General Summary of Progress." These have gradually increased in the successive years from 16 pages in the volume for 1871, to 272 in that herewith presented.

The editor has been pleased to notice that his endeavors thus to increase the value of the work have been on the whole cordially appreciated by the public at large. With much of praise, however, sundry friendly suggestions for modifications and improvements have been made which merit attention. It has been urged, on the one hand, that some new facts and memoirs deserving of attention have not been referred to; on the other, that the preliminary

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* Among those who have taken part in the preparation of the historical Summaries, or of abstracts of articles belonging to their respective specialties, or who have supplied early reports of their own original researches, may be mentioned: Professors Simon Newcomb, Cleveland Abbe, Edward S. Holden, Theodore Gill, and O. T. Mason, of Washington; Professors G. F. Barker, E. D. Cope, and Dr. William Wahl, of Philadelphia; Professor C. F. Himes, of Carlisle, Pa.; Dr. Charles Rau, of New York; Dr. E. S. Dana, of New Haven; Professor W. O. Atwater, of Middletown, Conn.; Dr. T. Sterry Hunt, of Boston; Dr. A. S. Packard, Jr., of Salem; Professor Asa Gray and Dr. W. G. Farlow, of Cambridge; Professor Hamilton L. Smith, of Geneva, N. Y.; Professor F. W. Clarke, of Cincinnati; Prof. A. W. Bennett, of London, and other gentlemen who prefer to remain unnamed.

Summaries of Progress would be sufficient alone, without any paragraphs recording individual discoveries. It would, of course, be impossible to satisfy such discrepant opinions, and in this dilemma the only resource left to the editor has been to follow a mean which he hopes will be regarded by most as a tolerably happy one. It must be remembered that far more than ten times the space contained in the present volume would be necessary to give even an approximately complete abstract of the progress of science in each of the departments embraced within the scope of this work: much more than that amount will in fact be employed in the annual reports that are hereafter to be made and published on the progress of the several departments of science for the past year. These reports, for 1875, however—unlike the present volume—will not appear till at least one, and, in some cases, two or three or even four years have elapsed. These too are, to a certain extent, addressed rather to experts and special students in the various branches of science than to the general reader, for whom the "Annual Record" is more especially designed. In them the several branches embraced herein are respectively reported upon, in volumes varying from little less than five hundred pages to nearly two thousand each year. Each special department of science has now its own organ for the record of discoveries within its domain. All these are extremely useful to the investigator, and enable him to economize precious time, that would otherwise be spent in frequent reference to numerous volumes, some of which are almost or quite inaccessible to all save a favored few. Several, also, are very elaborate, and the special subdivisions within a single branch are reported upon by experts in the respective subdivisions. Excellent examples of such reports are found in the *Jahresberichte* and *Jahrbücher*, published in Germany, on the mathematical, physical, and chemical sciences. Some branches have even two or more annual works devoted to the record of progress in their several spheres; such are especially Zoology, on which one report is published in Germany and another in England; Botany, which has one in Holland and another in Germany; while for Anatomy there are two in Germany alone. To reports like these (for the most part enumerated in the volume for 1874) must the student refer who desires to obtain information respecting the more technical or special facts or generalizations that have been announced. The present volume can administer to their needs only to a limited extent. But the editor hopes that by the relations which he has established with a number of the most eminent cultivators of the different departments of science in this country, and through their co-operation, he has been enabled to present as complete and reliable a résumé of discovery as can reasonably be expected within the limited space to which an annual like the present must be restricted.

As now presented, the *Record* has two distinct parts: (1) the historical summaries of progress during the past year, and (2) the paragraphs communicating in brief the results of investigations by special scientists, or respecting certain subjects. The advantages of the paragraph method, so generally in vogue in analogous publications in the English and other languages, are combined with the more consecutive and eliminating characteristics of the historical; the latter is a much more prominent feature in the present volume than in any of its predecessors, and special attention will be devoted to it in the future.

A list of some of the more prominent publications on scientific subjects which have appeared during the past year has been prepared for this volume. In the selections for this list we have been chiefly guided by the commendatory notices which have appeared in the more prominent scientific journals of the day, and references to the pages of the journals wherein the works catalogued are reviewed are given. As the journals in question are generally easily accessible, the reader is thus furnished with a trustworthy guide in his selection of books.

SPENCER F. BAIRD.

SMITHSONIAN INSTITUTION, WASHINGTON, *March* 28, 1876.

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[*] In the arrangement of articles in the body of the *Record*, it was found impracticable to place them in proper systematic sequence, especially as many belonged as much to one division as to another, sometimes even to three or four equally. The present systematic Table is intended to remedy the difficulty, by bringing together in proper order all the titles of articles, and, by a system of cross references and duplications, to point out all matter relating to any one subject, whatever be its situation in the volume. The references in Roman letters preceding the page references of the headings relate to the pages of the introductory "Summary."

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GENERAL SUMMARY

OF

SCIENTIFIC AND INDUSTRIAL PROGRESS DURING THE YEAR 1875.

MATHEMATICS AND THEORETICAL MECHANICS.

On account of the importance of the cultivation of pure Mathematics among American scientists, we note first that the editor of *The Analyst*, Professor J. E. Hendricks, of Des Moines, Iowa, states that a number of his subscribers have concluded to discontinue their subscriptions, since the subjects discussed in that mathematical journal are too difficult, and some of his friends advise him to make the contents of *The Analyst* somewhat more elementary, and to give small premiums to clubs, prizes, etc. He states, however, that the publication was inaugurated, not with the hope of being able to make it popular at present, but for the purpose of affording a medium for the interchange of thought by students and teachers of mathematics. Hence he does not anticipate that any person will subscribe who will not derive from it knowledge to the extent of its cost; and that *The Analyst* will continue to be a medium for interchange of thought, but will not become to any great extent purely an educational journal. The great good that will result to the progress of mathematical studies in this country by the presence among us of a good mathematical journal is sufficient to justify Mr. Hendricks in his self-imposed labors and expensive undertaking.

American mathematicians have contributed two valuable papers to the theory of the movements of systems of planets, etc. Of these, the first, by Newcomb, on the "General Integrals of Planetary Motion," was published by the Smithsonian Institution; the second, by Hill, on the "Development of the Perturbative Function," is to be found in *The Analyst*.

The theoretical researches of Le Verrier into the movements and general perturbations of the eight principal planets having at length been brought to a conclusion, he has presented an account of them to the French Academy of Sciences, and announces that his tables of Saturn, Uranus, and Neptune are rapidly approaching completion.

The somewhat startling announcement recently made by Mr. Stockwell, of Ohio, that he had discovered important errors in the mathematical portions of the accepted lunar theories, and which he has undertaken to correct, has, we believe, been negatived by the reply of Schjellerup, of Copenhagen, according to whom the error is apparently on Mr. Stockwell's own side.

Veltmann applies to the general law of movements of three or more bodies the calculus of determinants, and in this way arrives at some interesting formulæ.

ASTRONOMY.

Observers, Observatories, and Instruments.—The publication of the excellent series of astronomical engravings has been concluded by the Observatory at Harvard College. The text is also prepared, and will probably be published immediately on the appointment of Professor Winlock's successor.

The observatory erected on the grounds of Columbia College, in New York, has been connected with the systems of telegraph lines throughout the city, and will, it is hoped, soon be in a position to systematically furnish standard time to that city.

The great Cassegrainian reflector, of 26 inches' aperture, constructed by Dr. Henry Draper, has been properly mounted in a dome, with every convenience for use, at his father's country-seat at Hastings-on-the-Hudson; but its great powers have not, as yet, on account of bad weather, been fully demonstrated. For the sake of astronomy in America, it is to be hoped that he may be able to wrest from many business cares some time for the prosecution of astronomical physics.

In connection with the observations of the transit of Venus, it should be mentioned that the American parties owe a great deal of their success in photographic matters to the friendly counsel of Dr. Draper, who very generously devoted two months' time to the proper outfit of the parties in this respect, and who has received in return, from the Transit of Venus Commission, a beautiful gold medal, as an acknowledgment of his gratuitous services.

The observatory erected several years ago by Professor Mayer in connection with Lehigh University, and now for some time unused, has been placed in charge of Mr. C. L. Doolittle.

The directorship of the observatory at Cincinnati, which has been vacant since 1872, has recently been filled by the election of Mr. Ormond Stone.

The hopes expressed in the *Annual* for 1874, as to the speedy realization of the great project of Mr. James Lick, of California, have been somewhat dampened by the occurrence of a legal controversy — which seems an inevitable attendant of every great bequest for the advancement of learning. The original trustees having returned into Mr. Lick's hands the trust confided to them, he appears now, from what we can gather, to have personally interested himself in the execution of his own plan; and it is announced that he has made a formal offer to the trustees of Santa Clara County, in which he proposes to erect his observatory, on the summit of Mount Hamilton, provided the proper authorities will be at the expense of a well-graded carriage-road from the base to the summit.

The rage for large objectives continues as active as ever. It is said that the glass for making one of 30 inches in diameter is now held by Yale College.

The report of the National Observatory of the Argentine Confederation for the year ending November, 1874, has been received, and it appears therefrom that Dr. Gould, the director, has labored with an energy rarely equaled for the consummation of the great works undertaken by him.

For the new observatory at Quito, under the superintendence of Father Menten, a fine telescope has been constructed by Merz. It has a clear aperture of 9 Paris inches, and a focal length of 117 inches.

It is stated that Professor Gonzalez, director of the National Observatory at Bogota, has resigned his position in order to establish a new and private observatory, at an altitude of nine thousand feet, in latitude 4½° north.

The new observatory at Oxford has received as its director the Rev. C. Pritchard, Savilian professor of astronomy at the university.

The observatory at Twickenham, belonging to Mr. Bishop, and for a long time occupied by Mr. Hind, as observer, is shortly to be dismantled, and its instruments presented to the Royal Observatory at Naples.

The astronomical school established at Montsouris, under the authority of the French Bureau of Longitudes, was opened on the 3d of October with six pupils. The period of study is six months.

The new meridian room, intended for the use of the French Bureau of Longitudes, was opened on the 2d of October.

A magnificent astronomical establishment is being erected at Potsdam for the express purpose of studying the sun.

The French government has taken steps toward the establishment of a physical observatory in the neighborhood of Paris, under the direction of Janssen. The building will probably be located either at Versailles or Montelhuy.

Le Verrier proposes to furnish ordinary standard time by telegraphic communication to all the public clocks of Paris.

The observatory of the University of Moscow, Russia, has published the second volume of its annals, which contains valuable photographs of a series of sixteen drawings of the belts of Jupiter, and of the physical appearance of Coggia's comet.

The Melbourne Observatory has published the first "Melbourne General Catalogue of Stars."

Mr. C. W. Pritchett has received an endowment of $30,000 for the observatory of the Pritchett Academy, at Glasgow, Missouri. The observatory possesses one of Alvan Clark's 12-inch equatorials.

The observatory of the Lehigh University, at Bethlehem, Pa., organized by Professor A. M. Mayer, has secured Mr. Doolittle as astronomer. Mr. Doolittle was formerly on the Northwestern Boundary Survey, and hopes to make good use of his present opportunities.

The observatory at Gettysburg, Pa., has been placed in charge of Professor P. H. Bickee.

Mr. Sayce has given some interesting items with reference to the early history of astronomy among the Chaldeans. According to him, astronomy was brought to this people by the Acadians, who, when they came westward from the mountains of Elam, found a cognate race already settled in Chaldea. Having with them built the great cities of Babylonia, they were themselves subsequently, between the 30th and 40th centuries B.C., conquered by the Semites, who are known to history as the Chaldeans. By this ancient people the divisions of the zodiac, the days of the week, the months, and the year were established. Four and sixty were their most favorite subdivisions and multiples.

Mr. T. J. Lowry, of the Coast Survey, describes a new instrument based upon the principle of the sextant, by which two adjacent angles can be at once measured by one observer. It therefore allows one person, by observing three distant stations, to fix his position in the three-point problem; the new instrument will doubtless prove of great service in surveying.

Mr. Christie states that he has been employing for a year past the photometer invented by him, and finds that the probable error of a stellar magnitude is only the twentieth part. A feeble red star is, according to him, more easily distinguished than a feeble blue star.

It is proposed, on the occasion of the celebration of the centenary of the Genevan Society of Arts, founded in 1776, to distribute prizes to the makers of those chronometers which withstand the somewhat severe test applied by the committee of examination.

The astronomical necrology embraces Mr. Henry Twitchell, who died on the 26th of February at Cincinnati, at the age of 59. Mr. Twitchell was for twenty years the honored assistant and the principal observer at the observatory of that city. Strictly speaking, he was the contriver of the first chronograph ever constructed.

Hofrath Hennert Schwabe died, at the age of 85, at Dessau, Germany. His discovery, after forty years of observation, of the periodical nature of the phenomena of the solar spots, will long remain a brilliant example of the value of persevering observations.

The Sun.—The most important researches on the solar phenomena have been those of Professor Langley, of Pittsburgh. As the result of some six years' patient observations he has been able greatly to add to our knowledge of the peculiarities of the sun. After having succeeded in optical analyses of the structure of the solar surface, as was explained in the *Annual* for 1874, he has now called to his aid photometry and the thermo-electric pile. He finds that the nuclei of the solar spots are cooler than the neighboring bright portions of the sun's surface, but in general warmer than the limb of the sun as seen through the solar atmosphere. He has, moreover, shown that the light and heat which we receive from the sun emanates from the superficies of the nucleus, which is covered by a thin layer of gaseous material, which latter absorbs both heat and light; but in so doing exercises a distinct selective power in that the absorption of the lower or heat rays of the spectrum is to the absorption of the visual rays as one to six. He finds, moreover, that a sensible amount of heat is received from those portions of the lower envelope that are distant thirty seconds of arc from the visible limb of the sun.

Pickering and Strange have investigated, photometrically, the amount of light absorbed by the solar atmosphere. The probable error of the result is exceedingly small, and shows that the light at the edge is about four tenths of that at the centre. It appears to them that there is a slightly different distribution of the light across the polar and the equatorial diameters.

Professor Mayer has continued to develop his method of obtaining the isothermals of the solar disk, and is now having a telescope arranged for the purpose of making continuous observations in this novel and interesting field. He suggests that the discordance in results obtained by Secchi and Langley may possibly be due to the fact that these observers have thrown the image of the sun upon inclined instead of horizontal disks of paper, thereby introducing superficial currents of air, whose presence he found extremely deleterious to his own results, and which were almost entirely obviated by employing a perfectly horizontal plane of projection.

Although our review strictly begins with November, 1874, yet we will not omit to notice the work of Violle, published a little earlier than that date, on the effective temperature of the sun. Assuming that the mean emissive power of the sun is sensibly equal to that of steel in fusion, Violle concludes that the true temperature of the sun is about two thousand degrees.

As the first-fruits of the labors of the spectroscopic examination of the spectra of transparent substances, Lockyer announces the probable existence in the solar reversing layer of strontium, cadmium, lead, copper, cerium, and potassium.

The eclipse of the sun of the 6th of April was successfully observed, the photographic observations in Siam being especially successful. It is considered that evidence of high importance was obtained bearing upon the general nature of the spectrum of the coronal atmosphere; the tendency being to conclude that the higher regions of the solar envelope differ chemically from the lower regions; the lower portions, in fact, being composed of less complex chemicals at a high temperature, while the lower temperature of the upper portions allows of the formation of more complex bodies.

Fuhg has published a discussion of numerous observations of the diameter of the sun, and finds no difference between the polar and equatorial diameters. The views of Father Rosa as to the variable diameter of the sun have been already noticed by us. These views have been lately defended by Secchi, as the editor of the posthumous papers of Father Rosa.

The Planets.—Le Verrier has presented to the Paris Academy of Sciences his numerical tables of the movements of Saturn. They are based principally upon the observations at Greenwich and Paris. This completes his work for all the bodies of the solar system.

The measurements obtained by Colonel Tennant by means of Airy's double-image micrometer during the transit of Venus have been subjected by him to some discussion, and he thinks he has a decided indication of the elliptic form of the disk of the planet Venus.

Dr. Galle has published the results of his discussion of the observations of the asteroid Flora, which were made in concert by various observatories for the determination of the solar parallax. His definitive result is 8.87″, which agrees very closely with the preliminary results derived by M. Puiseux from French observations of contact. From the concourse of various methods to its determination, we may be sure that this important element will soon be accurately known. No results for the value of the solar parallax, based on measurements of photographs, have yet been published.

The following table presents some of the recently published values of the solar parallax:

From Cornu's experiments, using Bradley's aberration constant	parallax	=8.88″
From Foucault's experiments, using Struve's aberration.	“	=8.86″
From opposition of Mars, 1862	“	=8.84″
From Le Verrier's discussion of transits of Venus, 1761 and 1769	“	=8.85″
From Le Verrier's discussion of meridian observations of Venus	“	=8.87″
From Galle's discussion of the observations of Flora	“	=8.87″
From Puiseux's preliminary computation of transit of Venus observations, 1874	“	=8.85″

To which we may add from Newcomb's "Investigation of the Distance of the Sun:"

From lunar equation of the earth	parallax	=8.81″
From parallactic inequality of the moon	“	=8.84″
From Powalky's discussion of transit of Venus, 1769	“	=8.86″
From meridian observations of Mars, 1862	“	=8.84″

Mr. Marth calls the attention of possessors of large telescopes to the ease with which they may make observations of the movements of the satellites of Saturn and Jupiter, as he is anxious that observations should be made for the improvement of the theory of the satellites of Saturn.

The new asteroids discovered since the date of our previous list are as follows:

No.	Name.	Date—1875.	Discoverer.
141	Lumen	January 13	Paul Henry, at Paris.
142	?	January 28	J. Palisa, at Pola.
143	Adria	February 23	J. Palisa, at Pola.
144	Vibilia	June 4	C. H. F. Peters, at Clinton.
145	Adeona	June 4	C. H. F. Peters, at Clinton.
146	Lucina	June 8	A. Borelly, at Marseilles.
147	Protogenia	July 11	Schulhof, at Berlin.
148	?	August 7	Prosper Henry, at Paris.
149	?	October 6	Perrotin, at Toulouse.
150	?	October 18	J. C. Watson, at Ann Arbor.
151	?	November 1	J. Palisa, at Pola.
152	?	November 2	Paul Henry, at Paris.
153	?	November 2	J. Palisa, at Pola.
154	?	November 4	Prosper Henry, at Paris.
155	?	November 8	J. Palisa, at Pola.
156	?	November 22	J. Palisa, at Pola.
157	?	December 1	A. Borelly, at Marseilles.

These asteroids have, when first found, generally appeared as stars of the twelfth or thirteenth magnitudes; whence we may realize the extreme care with which the heavens must be searched by the asteroid hunter.

It is proposed at the Paris Observatory to institute systematic observations looking to the detection of any intra-mercurial planets. It is intended to photograph the disk of the sun daily, when it is believed the intra-mercurial planets, if any exist, will be observed photographically as they are crossing the disk of the sun.

The drawings of the appearances of the planets have been undertaken with especial interest. Of these we may mention a series made by M. Knobel of twenty-four drawings of Jupiter, and a similar series by Dr. Lohse at Bothkamp. The great equatorial at Washington has also been employed in this field, both by Professor Holden and by Mr. Trouvelot, who is so well known for his beautiful drawings made at Cambridge by the aid of the Harvard College refractor. Terby, of Brussels, is editing the long-lost work of Schroeter on the planet Mars, embracing over two hundred drawings.

Mr. Todd, formerly of Amherst, Massachusetts, now of the Observatory at Washington, contributes a good series of observations of Jupiter's satellites, extending over four years. Should he be able to continue this series for several years longer at Washington, it will form an important contribution to our knowledge of these satellites, and also of the time of the rotation of the earth itself.

Flammarion has observed and studied carefully the brightness and color of Jupiter's satellites. Schmidt and Heis have published in full their observations of the Zodiacal Light. It is to be hoped that the observations of Rev. J. Jones may also one day see the light.

Gyldèn's method of computing the special perturbations of the asteroids has been applied by Boeklund to the preparation of tables of the movements of the asteroid Iphigenia.

Comets and Meteors.—During 1875 we have received no announcement of the discovery of any new comet; but two well-known and exceedingly faint periodical comets have been observed a few times. The record for the year is therefore—

No.	Observed.
I. Encke's comet	January 26, 1875, by Holden, at Washington.
II. Winnecke's comet	February 8, 1875, by Stephan, at Marseilles.

The fine comet which was visible in 1874, and known as Coggia's comet, gave occasion for several interesting observations, some of which have been published during the past year. Among these, we notice those having a bearing upon its physical constitution, such as Mr. Ranyard's polariscopic observations, showing the absence of a sensible amount of polarized light, whence he concludes that the substance of the tail is either incandescent, or else made up of atoms which are small compared with the wave-lengths of the light. Mr. Christie's spectroscopic observations show that in the spectrum of the comet two bright bands were found on every occasion, sensibly coincident with the two brighter bands of carbon dioxide. The spectrum of the nucleus was continuous, and appeared to contain numerous bright bands, and occasionally dark lines. The other observations, in so far as they have been published on this body, were referred to in our previous volume.

Secchi's observations of the spectrum of Coggia's comet show that it agrees best with the spectrum of the oxides of carbon; but the polariscope shows that the continuous spectrum was only the reflected light of the sun; and Vogel, in a general review of the questions relating to cometary spectra, concludes that there is some probability that the gases present in comets are hydrocarbons.

Encke's comet, one of the faintest comets familiar to astronomers, has been observed in the northern hemisphere at Washington with the twenty-six-inch refractor, and at Marseilles with the large reflector of that observatory. Accounts of equally successful observations have also reached us from the Melbourne Observatory.

Winnecke's comet has been observed at the Harvard College Observatory.

Highly interesting analyses of two meteorites have lately been made by Mr. A. W. Wright, of New Haven, which, besides being valuable as careful determinations of the chemical constituents of the two specimens examined, directly attack the question of the relation of meteorites to comets. Professor Wright finds that, under suitable conditions of pressure, the gases extracted from the meteorite itself (and therefore of an extra-terrestrial origin) show the same three bands which are characteristic of some of the comets, and that not only are these bands in precisely the same relative positions as the comet-bands, but they have likewise the same relative intensity.

In a second paper on the same subject, Wright concludes, first, that the stony meteorites are distinguished from the iron ones by having the oxides of carbon, chiefly the dioxide, as their characteristic gases, instead of hydrogen. Second, the proportion of carbon dioxide given off is much greater at low than at high temperatures, and is sufficient to mask the hydrogen in the spectrum. Third, the amount of the gases contained in a large meteorite, or a cluster of such bodies serving as a cometary nucleus, is sufficient to form the train as ordinarily observed. Fourth, the spectrum is closely identical with that of several of the comets.

The question as to the identity of Biela's comet and that discovered by Pogson, at Madras, on the 2d and 3d of December, 1872, has been investigated by Professor Bruhns. He demonstrates that there was no connection between the two, nor even between Pogson's comet and the shower of shooting-stars of the preceding 27th of November.

Professor Kirkwood concludes that, besides the shower of meteors that occurs on the 12th of November, another class of meteors has been occasionally observed on the 14th of November, which latter is probably a small fragment of the principal group, having been separated from them within historical times, in consequence of considerable perturbations either by Uranus or the earth.

The August meteors were well observed in France by the members of the Meteor Association organized by the joint scientific associations of France.

Fixed Stars.—Of stellar atlases, the only original ones that have been published of late are:

First, that of Dr. Behrmann, which embraces the region between the south pole and 20° south declination, and gives the position of all stars visible to the naked eye. Although the magnitudes of the stars were actually observed by Dr. Behrmann in the course of ten months, yet all the other data of the atlas have been compiled from the older star catalogues.

His atlas, therefore, although valuable as the best southern atlas at present at hand, must expect to be superseded by the "Uranometria Argentina," so soon as the latter shall be published by Dr. Gould. This important work of Dr. Gould is, we are assured, already in the hands of the engravers, and may be expected within a reasonable time.

Second, the continuation of the famous star charts known as Chacornac's, a work which has recently been revived under Le Verrier at the Paris Observatory.

Third, the Imperial Academy of Sciences of St. Petersburg has published, under the editorship of Schjellerup, a "Uranometria" composed in the middle of the tenth century by the Persian astronomer, Al Sufi. This chart of the heavens seems to be compiled from original observations; and the changes of color and brightness undergone by the stars since that time, as shown by comparing Sufi's and Argelander's uranometriæ, are of special interest.

A catalogue of absolute right ascensions of stars has been compiled by Professor Gyldèn, of Stockholm, for use in the reduction of his own observations at that place. The positions given by him, although entitled to great weight, yet can scarcely be considered to supersede those published a few years ago by Professor Newcomb.

Villarceau announces a method of determining both the aberration of light and the motion of the solar system among the stars, by means of observations in both hemispheres. It is to be hoped that this plan will be put into execution.

The Melbourne Observatory, under the direction of Mr. Ellery, has published the first "Melbourne General Catalogue of Stars," based upon observations made from 1863 to 1870. This contains the places of 1227 stars, with all the auxiliary constants necessary for their convenient use; and the proper motions of the stars have been determined with as much accuracy as was practicable. A remarkable star, *Epsilon Indi*, is found to have certainly the very large annual proper motion of 4.6″, and is an inviting subject for the determination of the annual parallax.

Mr. E. J. Stone has published the Cape Catalogue of 1159 stars observed between 1856 and 1861.

The scintillation of the stars continues to be investigated by Montigny, who has invented an ingenious apparatus which he calls a scintillometer. He finds that those stars which scintillate or twinkle least are those whose spectra show numerous well-pronounced lines, sometimes united in zones.

Messrs. Smythe and Duncan have shown that the star known as B.A.C. 793 has an unusual large proper motion, and that it is important to continue observations thereon.

Especial activity has been manifested in the computation of the orbits of double stars, for which work a great mass of accurate observations has now accumulated, through the labors especially of the Struves, Herschel, Dawes, Dembowski, South, and Secchi, not to mention a host of others who have contributed to a less degree. Of those whose orbits have been investigated during the past year, we note that of 70 *Ophiuchi*, as computed by Flammarion; *Zeta* Aquarii and *Gamma* Leonis, as computed by Doberck, of Markree.

Mr. Alvan Clark calls attention to the rapid angular motion of *Mu* Herculis.

An investigation of the movements of the double star 42 *Comæ Berenices* has been made by Otto Struve, and his assistant Dobiago. They conclude that the most probable period of revolution of the two stars is twenty-five and seven-tenths years; but the plane of the orbit of these stars passes so directly through the solar system that the elliptic orbit itself appears as a straight line. The computations of Struve have therefore been based entirely upon the observed angular distances of the two stars. In the course of this investigation, Struve takes occasion to state that, in observing very close double stars which appear sometimes as an oblong single star, the centering of the object-glasses of the telescope is an important consideration, as a very small error would lead to a considerable error in the estimated position-angles of the two stars.

Another double star whose orbit has been investigated is *Eta Coronæ*, concerning which Mr. Wilson states that recent observations show a systematic divergence from the orbit published in 1856 by Winnecke. The hypothesis that best suits all known observations is that at each successive revolution of the stars there exists some shortening of the period.

One of the most extensive works undertaken by Sir John Herschel was the compilation of a catalogue of all known double stars: a work which he did not live to complete, but bequeathed in its incomplete state to the Royal Astronomical Society, by whose authority it has been published as a catalogue of 10,300 multiple and double stars. A most important portion of this work was left uncompleted by its author, and has not been published by his editors. We refer to the descriptions of the distances, magnitudes, and colors of the stars. This important defect in the work, as it now stands, will, we have reason to hope, soon be supplied by the publication by the Naval Observatory at Washington of a far more important catalogue of double stars that has been in process of compilation during some years past by Mr. Burnham, of Chicago. This gentleman, by far the most industrious amateur astronomer in this country, has continued to make numerous contributions to this branch of astronomy, his labors being confined to the detection of new and extremely difficult companions to well-known stars.

The Hamburg Observatory has issued its first official publication in the shape of a memoir by Helmert on the stars of the cluster in Sobieski's Shield, the same cluster which was studied by Lamont in 1836. But slight movements of the individual stars can be deduced from a comparison of Helmert's and Lamont's observations, although they were separated by an interval of forty years.

Nebulæ.—The nebulæ have been studied of late from several points of view. Drawings of the more famous ones have been made in the United States at Washington by Holden, and at Cambridge and Washington by Trouvelot. In the southern hemisphere we note several contributions by Ellery at Melbourne.

The question of secular changes in the appearances of nebulæ can, it would seem, be best decided by making careful drawings of them at the present time as seen through telescopes of very feeble power, such as were necessarily used by the early astronomers. In this way Temple has traced the outline of the nebula near Merope, describing it as elliptical; while Wolf, at Paris, using a somewhat larger telescope, perceived two nuclei distant seven seconds from each other. Stephan having been unable to discern the nebula with his large telescope during the winter of 1874–5, it has been concluded that this nebula is certainly variable.

One of the most valuable catalogues of nebulæ yet published is that of Schultz, of Upsala, who has observed the exact positions of about five hundred of these bodies with reference to neighboring stars, thereby preparing the way for determinations, to be made possibly a hundred years hence, of the proper motions of these nebulæ.

PHYSICS OF THE GLOBE.

Tides.—One of the most useful works that has appeared of late years on the subject of tides has been published by the Coast Survey. Its author, Professor Ferrel, has given in detail the formulæ needed in the discussion of long series of tidal observations, and has treated specially the subject of shallow water tides. Professor Ferrel has also been able to deduce the mass of the moon with a high degree of accuracy, after taking account of the influence of friction.

Mr. Rohrs, in a paper on tidal retardation, has discussed the problem of maximum retardation on a globe entirely covered by a sea whose depth is constant for all points in the same latitude, but varies from the equator to the poles.

Sir William Thomson announces his conclusion that the much-vexed question as to the generality and correctness of Laplace's tidal investigations must be at last decided in favor of that great mathematician, and that therefore Airy's criticism falls to the ground, as also that of Ferrel. Airy's reply to Thomson will probably serve to prolong the discussion of this obscure but highly important question.

Seismology.—The investigations of La Saulx upon the earthquakes of Western Prussia have led to the authorization by the Prussian government of the establishment of a large number of seismometric stations in the volcanic region near Bonn.

Rev. O. Fisher has communicated a paper to the Cambridge Philosophical Society, in which he states that his attempt is to arrive at more definite conclusions in regard to the elevating force which has raised mountain ranges and caused the wrinkling of the crust of the earth.

The earthquake phenomena of Southern Austria have been elucidated in a valuable memoir by Suess, who shows that the centres from which earthquakes emanate are. in that country, all ranged along certain straight lines or belts, which, in one remarkable instance, coincides with a river valley so perfectly as to afford the basis for very plausible speculations as to the dependence of the earthquakes upon the infiltration of surface water.

A series of terrible earthquake shocks is reported to have occurred in the month of May in the province of Borussa, in Asia Minor. Hundreds of houses have been destroyed and lives lost.

Perrey has published another great catalogue of earthquakes; the present volume being especially devoted to the year 1871.

The minute vibrations that for some days attend and generally precede severe earthquakes have been especially observed and studied by Serpieri, who in "Meteorologia Italiana" gives some of his conclusions as to the use of the pendulum seismograph in predicting earthquakes.

Terrestrial Magnetism and Auroras.—One of the finest publications in the department of terrestrial magnetism is the quarto volume recently received from the observatory at Trevandrum. This is the first of a series of volumes published at the expense of his Highness the Maharajah of Travancore. Dr. Broun, who was the director of the observatory from 1852 to 1865, is the editor of the present volume, and in it he has given a fine example of the good results that may be obtained by a careful study of every possible source of error in the instruments and observations.

Equally extensive is the large quarto published by the Dutch government in Java, and giving in detail the magnetic and meteorological observations made from 1866 to 1870 at Batavia under the direction of Bergsma. Many general results are given in the Introduction to this volume, and the whole contains a most important contribution to our knowledge of the climate of that portion of the Pacific Ocean.

The subject of "terrestrial electricity" has been studied on a grand scale by Schwendler, electrician to the Indian government. Over ten thousand observations made under his direction during the past six years on telegraph lines in India have shown that there is a uniform ground current from east to west, and have paved the way for improved methods of investigation, which it is believed have, ere this, been authorized by the Indian government.

One of the most valuable contributions to the literature of the subject of auroras consists in the new general catalogue of auroras compiled by Fritz, of Zurich, and published by the Vienna Academy of Sciences. This author has added even to the great catalogue of Lovering, in that he had access to documents now for the first time rendered accessible. He has employed the great mass of data collected by him in a minute investigation into the geographical distribution of the aurora, and concludes that auroral frequency has to do with the distribution of ice in the arctic regions.

Highly interesting auroral observations have been made on the auroras by Tromholdt, who concludes that there is a connection between auroras and halos; but the most valuable contribution on this subject is from Weyprecht, in the preliminary reports on the results of the Austro-Hungarian North Pole Expedition of 1872 and 1873. According to him, very intense auroras were invariably followed by storms. Quite regular arches, without color or radiation, exercised no apparent influence on the needle.

METEOROLOGY.

Observers, Institutions, Instruments, etc.—Of government establishments, the most important change has been that at the Hamburg Seewarte, which has been purchased by the German government. The "German Seewarte" at Hamburg is now organized as an office of the Royal Hydrographic Bureau. To it are assigned the duties, first, of caring for ocean meteorology and the interests of navigation; second, of showing storm warnings on the German coast; and, third, the investigation of the meteorological conditions on which storms depend. It seems to be intended to abandon all studies of climatology, and to restrict its field of activity quite exclusively to simultaneous observations of the atmosphere, or to meteorology proper.

The meteorological service of Bengal, under Mr. Blandford, has begun the publication of daily weather maps for the Indian provinces. Reports are published daily, in addition to the bulletins, showing the weather. The reports of 145 rain-gauges, in addition to six first-class and ten second-class stations, have been published.

These will form an important extension of the maps which Meldrum began to compile in 1854 for the whole Indian Ocean, and which it is understood he still keeps up.

The meteorological office of the Argentine Confederation having been organized by Dr. B. A. Gould, he has continued to maintain a general superintendence of its work; and from his report of its activity during the year 1874, it appears that seventeen stations are occupied by him; his general rule will be, as he states, excellence in a few researches, rather than a wider range of inquiry with a probable sacrifice of accuracy.

The Russian government, following the lead of France and Germany, has decided to establish at Pavlosk, near St. Petersburg, a new physical observatory, in connection with the central physical observatory in that city. In Japan, the department having in charge the island of Jesso has taken steps to have regular meteorological observations made therein. These will be in charge of Professor Rockwell, of Tokio.

The organization of French meteorological departments continues to progress. The southern Mediterranean region has for its central office Montpellier. The northern Mediterranean region is centralized at Marseilles. For the western and southwestern regions a special meteorological congress has been called, to be held at Poitiers.

The report of the proceedings at London of the Conference on Maritime Meteorology, in that it gives succinctly the recommendations of the Vienna Congress, is well worthy of reference to the attention of American navigators and observers.

An excellent manual of instructions for the use of observers, accompanied, of course, with convenient tables, has been published by the London Meteorological Office. In some respects its directions differ from those recommended by the Meteorological Congress at Vienna; and, in fact, we seem to be as far as ever from realizing that absolute uniformity of methods and instruments which would be so conducive to the progress of science.

Dr. Mills communicates to the Physical Society of London some suggestions on thermometry. For thermometers which have not been used, the zero-point error must always be determined immediately after experiment. It is also generally necessary to correct for the projection of the stem of the thermometer beyond the bath in which the bulb is immersed. The author, having made nearly two thousand observations for each of the instruments used by him, concludes that the well-known expression given by Regnault does not agree with his experiments; he shows the exact nature of the errors of his own instruments, but concludes that every observer must make a similar investigation of his own thermometers.

Among the numerous new methods of mechanical registration of atmospheric phenomena, especial attention seems to have been secured for the meteorographs of Baumhauer, Rysselbergh, and Secchi.

An excellent self-recording mercurial barometer is described by Redier; and a mega-barometer, or one that measures the pressure of the air at any moment on an enlarged scale, has been constructed by Hirn.

Among self-recording thermometers, the most peculiar is that of Mr. Cripps, which is so constructed that the movements of the mercury in the tube of the thermometer disturb the position of equilibrium of the whole instrument, inasmuch as it is delicately poised on two pivots. The consequent movement, which is due essentially to the force of gravity, is made serviceable for the purpose of registration.

Constitution of the Atmosphere.—Williams has made a photometric investigation into the intensity of twilight when the sun is at various distances below the horizon. He finds that at one minute after the sun sets the intensity of the radiation is $\frac{95}{100}$; at ten minutes after sunset it is $\frac{34}{100}$. Both this and the following investigation give us a means of expressing relatively the amount of moisture in the air.

Crosby, of the Massachusetts Institute of Technology, has made some photometric determinations of the light of the sky at different distances from the sun. The results, represented graphically, show a logarithmic curve when the intensities are plotted as ordinates, and the natural sines of the sun's angular distance as abcissæ.

The application of the spectroscope to the determination of the quantity of moisture in the atmosphere has been simultaneously studied independently by De Sains, in France, and Tait and Smythe, of Edinburgh. The latter agree that certain fine telluric lines in the solar spectrum become dark smoky bands when the quantity of moisture is abnormally great.

Schöne has given some careful measurements showing the presence in minute quantities of the hyperoxide of hydrogen in the atmosphere; and Dr. Ecke has published an extensive investigation into the relative quantities of oxygen in the air, and in the different climates and at different seasons. His studies have special reference to the sanitary advantages of certain localities.

Temperature of the Air.—Dove contributes to the Berlin Academy a valuable paper on the climatology of Germany, based on observations of temperature made during twenty-five years, from 1848 to 1872, at two hundred and six stations.

Celoria elucidates the general laws of variations of temperature, both annually and daily, by one hundred and ten years of observations at Milan.

From the examination of forty years of observations of the temperature at Brussels, Quetelet finds that the so-called cold days of May actually exist for that place, giving rise to a well-marked depression, amounting on the average of the whole period to three degrees of temperature.

Silbermann has observed the temperature of a small mass of black powder exposed to the sun's rays, and has applied his results to explain the cases in which the northern sides of mountain chains are more fertile than the eastern sides.

In reference to the production of frost, Ley states that a study of the upper currents of the clouds has shown him that, at least in England, frosts are preceded by a slight backing of the upper southwest and northwest currents.

Barometric Pressure.—The relations between the barometric pressure and the velocity of the wind have formed the subject of valuable contributions to the Journal of the Austrian Meteorological Association, where Hann has developed the mechanical formula of Ferrel, and given a translation of the work of Colding, of Copenhagen; the latter shows the perfect agreement of his formula with observations made during certain hurricanes in 1837 and 1871. Mr. Ferrel's formulæ are, however, preferable to Colding's.

A very complete review of the state of our knowledge with respect to the connection between barometric pressure and rainfall has been published by Hann, who has shown that we have no reason to believe that the condensation of atmospheric vapor directly causes large observable changes of pressure. In order, then, to understand why so great depressions of the barometer are observed in the midst of every storm, he finds it necessary to adopt the mechanical principles which have been developed so fully by Ferrel and others, and which have been adopted by some of the American meteorologists for many years.

In the application of the barometer to hypsometric purposes, we notice the empirical tables prepared by Professor Whitney and Mr. Pettee especially for the climate of California, which give corrections to be applied to the results of computation by the ordinary formulæ, in order to obtain more correct altitudes.

Winds.—The report of the permanent committee appointed at the Meteorological Congress at Vienna has recently been received, in which is given the proceedings of the meetings held by the committee, and in the appendix the papers communicated to it by the meteorologists of Europe. Among these, the greatest interest will attach to the short preliminary reports by Buys Ballot, of Holland, Wild, of Russia, and Scott, of England, on the relation between the velocity and the fôrce of the wind. An investigation of the same subject has also just been published by Hagen, of Berlin; and from his own, as well as the other papers referred to, it seems certain that the friction of the air blowing past the edge of a plain circular disk brings about an increase in the pressure experienced by that disk. So that the pressure is not, as ordinarily assumed, proportional to the area of the disk and the square of the velocity of the wind, but may be said to depend upon the circumference of the disk, and upon other powers of the velocity. A fuller investigation of this subject will be necessary before we can at all understand the effects produced by the power of the winds of tornadoes and hurricanes. The complete memoir by Dohrandt and Wild, of St. Petersburg, will be found in Wild's "Repertorium."

An important memoir by Blandford has been published under the title of the "Winds of Northern India," which, however, contains much more than the title would seem to indicate.

The relative direction of the movement of the upper and lower strata of the atmosphere has been carefully studied in Northern Europe by Hildebrandsson, who concludes that the higher currents of air are always directed toward points to the right hand of the lower currents, an expression which is much more general than that adopted by Hildebrandsson himself, but which will be found to be fully warranted if we compare the works of Redfield (1837), Ferrel (1859), Abbe (1871), and Ley (1872).

Storms.—Mr. W. C. Ley, well known by his valuable work on the barometer and the winds, states that, having worked for a considerable time at a comparison of the weather charts of the United States and Europe, he is convinced that only a small portion of the storms experienced on the American side of the Atlantic can subsequently be distinctly traced in Europe; and of these the majority are felt severely, not in Great Britain or France or Denmark, but in the extreme north of Europe. Many of the most destructive European storms occurred when the barometric pressure on the eastern coast of America was tolerably high and steady. They appeared to be developed on the Atlantic Ocean near the eastern limit of the area of high pressure. He does not believe in the utility to Europe of a system of storm predictions sent from North America, though it does not appear but what others may be in possession of the knowledge which Mr. Ley has not, and which would make such predictions invaluable to France and England.

The storms of the United States have continued to be especially studied by Professor Loomis, of Yale College, who has based his studies, as heretofore, on the daily maps of the Army Signal-office. He finds that centres of low barometric pressure tend to move toward centres of high pressure when the latter lie to the southward, but move from them when they lie to the northeastward. He concludes that about one tenth of our storms reach the European coasts.

In reference to the display of storm signals, we note that these are now shown from every important point along the whole German coast. The French system of storm warnings has experienced a new organization, dating from the 1st of March. The British system reports a percentage of eighty-four per cent. of verified storm warnings.

One of the most important publications of the year is the "Bulletin of International Simultaneous Meteorological Observations," published by the Army Signal-office Weather Bureau. This bulletin gives in detail the observations made at 7.35 Washington time simultaneously throughout the world. When entered upon a weather chart, we shall now have the means at hand for a comprehensive study of the movements of the atmosphere throughout the globe, we shall doubtless frequently be able to trace storms in their progress from America to England, and shall study the dynamics of the atmosphere on the proper scale.

The study of the atmosphere by means of balloon voyages has been diligently prosecuted. The only disastrous scientific voyage has been that of the *Zenith*, whose ascent on the 15th of April last was signaled by the death by asphyxia of two of the aeronauts—Croce Spinelli and Sivel. Notwithstanding this misfortune, De Fonville has resolutely carried out several experiments looking to the solution of any mystery that might have attended the death of those aeronauts; and he shows conclusively that they must have died of suffocation due to the rapid flow of gas from the ascending balloon. De Fonville maintains that balloon ascents may be made, if conducted gradually, to immense altitudes, even greater than those reached by Glaisher.

A very important branch of the insurance business is, in Europe, confined to the issuance of policies against damages by hail-storms. From a recent publication by the Wurtemberg Bureau of Statistics, it appears that during the forty-six years ending in 1873, thirty-five per cent. of the hail-storms have occurred in July, and twenty-eight per cent. in June, and less than one half per cent. in February and April; the earliest occurring on February 9, and the latest on September 25. Ten different years are enumerated in which damage to the extent of two million florins was reported by the insurance companies, while five years occurred in which the damages were less than five hundred thousand florins. The districts most frequently visited were the outlying spurs of the Alps. A comparison of the whole series shows that in Carinthia and in Wurtemberg a certain agreement exists as to the variable frequency of hail-storms in separate years, pointing to some common cause other than local influences.

In connection with this subject, we note the announcement recently received by us of the death, on the 18th of March, of J. Prettner, who, although director of an extensive manufactory of white-lead, found time to carry out most excellent climatological investigations in reference to his own country, and whose work on Carinthia has been quoted in the preceding sentences.

The vexed question of the influence of forests upon rainfall has been the subject of study of Fautrat and Sartiaux, whose observations have been made especially in the forest of Hachette, France. Their instruments were placed above the tops of the trees in the midst of the forest, which covers twelve thousand acres, and also at a similar elevation above the surface of adjoining portions of cleared land. The total rainfall over the forest was always larger than that over the cleared land; whence they concluded it to be demonstrated that forests form a vast apparatus for the condensation of moisture, and that there is more rain upon them than upon open land. We fear, however, that this conclusion will not bear the test of a very slight criticism, notwithstanding the value that must attach to the observations themselves.

Rev. C. Dade has examined the record for forty-one years of the weather in Canada with reference to the truthfulness of the popular saying, "Saturday's moon, the winds full; never was fair, and never will." He finds that the number of days of clear weather during the twenty days after a Saturday's full moon is quite the same as the number of days of clear weather for twenty days after a Saturday's new moon. The popular saying is therefore completely contradicted by actual observations; and further investigations into the connection between the phases of the moon and the weather will only confirm that conclusion which has so frequently been drawn by previous investigators that there is no perceptible connection between the moon and the weather.

PHYSICS.

The progress in Physics during the year has been marked. In *General Physics*, Clerk-Maxwell's lecture before the London Chemical Society upon the dynamical evidence of the molecular constitution of matter is to be noted, since it presents in an admirable way the conclusions which have been reached on this subject by mathematicians who have studied molecular physics.

Töpler has given an extended illustrated description of the admirable new physical laboratory which has just been erected by the Austrian government at the University at Grätz.

In *Mechanics*, Professor Sylvester states that by the study of linkages he has been led to the conception of a new instrument, by means of which a figure in the act of being magnified or reduced may at the same time be slewed around the centre of similitude. This instrument may be used, therefore, to transfer a figure from one position on a sheet of drawing-paper to any other position upon it, leaving its form and magnitude unaltered, but its position slewed around through any desired angle. Again, it enables us to apply the principle of angular repetition, to produce designs of complicated and captivating symmetry from any simple pattern or form, such as a flower or sprig; and still it may safely, by practice, be found to place a new and powerful implement in the hands of the engine turner, pattern designer, and the architectural decorator.

Rood has described in full the important modifications he has made in Zöllner's horizontal pendulum, and has given the extraordinarily delicate measurements he has made with it. The mean probable error of the average result of four sets of observations made with the apparatus is one tenth of a scale-division, corresponding to one thirty-six millionth of an English inch! Rood purposes to use this remarkable instrument for the purpose of studying minute changes, otherwise inappreciable, in the dimensions of solid bodies under various conditions.

Pfaff has made some experiments upon the plasticity of ice, in order to throw additional light upon glacier motion. In none of the hitherto recorded observations is any mention made of the amount of pressure necessary to change the form of ice, though Moseley observed that to pull apart an ice cylinder a weight of five and a half to nine atmospheres was required to the square inch, and to fracture it a pressure of seven and a half to nine atmospheres. Pfaff has sought to determine the minimum pressure at which ice yields, and has proved that even the slightest pressure is sufficient if it act continuously, and if the temperature of the ice and of its surroundings be near the melting point. In one experiment a hollow iron cylinder 11.5 millimeters in diameter sunk into the ice 3 millimeters in two hours, it being surrounded with snow, the temperature varying from —1° to +0.5°. When the temperature rose above the melting point, it sank 3 centimeters in one hour! scarcely a trace of water resulting. A steel rod a square centimeter in section, when pressed with one third of an atmosphere, sank into the ice 14 millimeters in three hours, the temperature being 2.5°. The flexibility of ice was shown by placing a parallelopiped 52 centimeters long, 2.5 centimeters broad, and 1.3 centimeters thick upon wooden supports placed near its ends. From February 8 to 15, the temperature varying from —12° to —3.5°, the middle portion sank only 11.5 millimeters. But the succeeding twenty-four hours the temperature was higher, and the middle of the bar sank 9 millimeters. From 8 A.M. to 2 P.M. the increase was 3 millimeters, when the bar broke, the temperature being +3°. The whole bending was 23.5 millimeters. Similar experiments were made upon the ductility of ice; it elongated by traction. From these results it is easily seen why a glacier's motion increases with the temperature.

Professor Nipher has made an elaborate investigation upon the mechanical work done by a muscle before exhaustion, the data given being more accurately determined than those published by him three or four years ago, and adopted as a basis for calculation by Professor Haughton, of Dublin.

De la Bastie has communicated to the Société d'Encouragement an account of his new process of tempering or hardening glass. The manufactured articles are heated to near the temperature of softening, and then cooled suddenly in a suitable bath of oil. The glass thus treated becomes extraordinarily resistant, in some cases amounting to fifty times that of ordinary glass. It becomes also very hard, so that difficulty is experienced in cutting it with a diamond. Though so resistant, it is very brittle. A piece when broken flies into a thousand fragments, exactly like the well-known Prince Rupert's drop. Vessels were shown of the new glass in which water could be boiled over a naked fire without fear of breaking them. Upon plates of it a weight of one hundred grammes was allowed to fall from a height of three and a half meters without fracture. Watch-glasses made of it remained intact when thrown across the room. The hardening process is not difficult nor costly, and it promises to become of great practical importance. Mr. Pockington states that he has examined by polarized light some specimens of this hardened glass, prepared by himself according to De la Bastie's method. Having prepared a small cube in this manner, its sides were ground plane and polished, and on examination by the polariscope it became at once evident that the contraction of the exterior of the mass must exert a powerful compressing force upon the interior. The outer surface of the glass can be made, according to his experiments, nearly twice as hard as ordinary glass. On grinding away either surface it is evident that the interior of the mass consists of ordinary glass, being little, if at all, harder than before the application of De la Bastie's process, and subject to fracture in the ordinary way. There appears to be a limit beyond which the opposite surfaces can not be unequally removed without producing such phenomena as, under the polariscope, show the existence of unsymmetrical tensions; but there is practically no limit beyond which both surfaces may not be simultaneously removed, as is shown by dissolving away the softer portions by means of hydrofluoric acid. De Luynes and Feil—the former well known from his researches on the Prince Rupert's drop—have also made some experiments on the hardened glass of M. De la Bastie. They find that this glass presents many points of analogy with the Prince Rupert's drop, as well in the mode of production as of fracture. Though it is not ordinarily possible to cut a piece of this glass with a saw, a drill, or a file without its flying in pieces, yet in some cases it may be done. A disk, for example, may be drilled through its centre without fracture, though not elsewhere. A square plate of St. Gobain glass thus hardened showed in polarized light a black cross, the lines of which were parallel to the sides. It is always possible to saw such a plate along these lines without fracture, though beyond them, either parallel or transverse to them, any attempt to cut the plate fractures it. If the two fragments of a plate thus cut be examined in polarized light, the arrangement of the dark bands and colored fringes shows the molecular state to have altered by the division. Placing the one plate directly upon the other in the original position, both bands and fringes disappear; while if reversed and superposed, the effect is increased, being that due to a plate of double thickness; hence the tension in the plate is symmetrical with reference to the saw-cut. We may conclude, therefore, that while hardened glass is in a state of tension, it may always be cut in certain directions when the resulting pieces can take a condition of stable equilibrium. This is easily determined by examination with polarized light. In the case of fracture the fragments are always symmetrically arranged with relation to the point where the equilibrium was first destroyed. The authors have also examined into the cause of the bubbles so generally seen in hardened glass. They find them to be produced at the moment of hardening, and to disappear, or nearly so, when the glass is annealed. They hence conclude that they are due to the imprisoning of minute masses of gas in the glass, these masses becoming enormously dilated when the glass is hardened; this dilatation, which is actually seventeen or eighteen hundred times the original volume, being caused by the contraction of the surrounding glass produced in the process of hardening.

Boudreaux has published a simple and more general method of demonstrating the Archimedean law of buoyancy in liquids. A glass vessel with a slightly conical lateral spout is placed beneath the pan of a hydrostatic balance, to which is suspended the body to be experimented upon. This vessel is filled previously, the excess of liquid being allowed to flow off through the spout. Two thin capsules are then provided; one of them is placed on the pan supporting the body, and is balanced by shot. The body is then immersed, the overflow of liquid being collected in the second capsule. The inclination of the balance beam shows the upward pressure. But on replacing the first capsule by the second, which contains the liquid displaced, the equilibrium is restored.

Carl has devised a simple apparatus for showing lateral pressure in liquids. It consists of a cylinder to hold the liquid, hung at its top upon a knife edge, and having a lateral opening near the bottom which can be closed at pleasure. An index attached at the top moves over a graduated scale as the cylinder varies from perpendicularity. The condition of equilibrium is regulated by one superior and two lateral balls. If now the cylinder be filled with water, it remains perpendicular; but on opening the orifice at the bottom the water pressure is relieved on that side, and the cylinder swings in the opposite direction. The apparatus may be made to show also the change in the form of the parabola as the height of the water column decreases.

Paquet has described a new densimeter, which is simply the instrument of Rousseau modified so that it can be used for solids. An ordinary hydrometer has an enlargement upon the top of the stem about half a square centimeter in section and fifteen centimeters long, closed at the lower end, and divided into cubic centimeters and tenths. A zero point is marked at the level of the second centimeter mark, and the instrument is so weighted that when the upper tube is filled with water to the zero level, it sinks in water to the bottom of the stem. To the water in the upper tube a definite weight, the maximum ever to be needed, is added—say, six grammes. The instrument sinks to a certain point, which is noted on the stem and marked 60, and the stem is divided between this mark and zero into sixty equal parts, the divisions being continued up if there is space. Each division corresponds to one decigramme. To use the instrument, two cubic centimeters of water are placed in the upper tube, and the whole immersed in water, sinking to zero. The fragment of mineral, for example, to be determined is placed in the water in the upper tube, and thereby raises its level three divisions; the volume of the fragment is therefore 3 c. c. The instrument sinks by the increased weight, say, to the fifty-fifth division; hence its weight is 55 decigrammes or 5.5 grammes. The specific gravity is 5.5÷3, or 1.83, therefore.

Arzberger and Zulkowski have proposed a new form of water air-pump, founded on the principle of the increased flow of liquids caused by an ajutage like an inverted frustrum of a cone. By a lateral opening, water, under considerable pressure, enters a small cylindrical box, upon the top of which is the air tube, entering about half-way, and narrowing to a point. This enters and opens into the narrow end of a slightly conical tube called the diffuser, which projects several inches below the box, and by which the water issues. The supply of water must keep the tube full, and as it widens downward there is an exhaustion. With 585 mm. of mercury pressure of water, the barometer standing at 735 mm., the vacuum produced was 724 mm., and the consumption of water three liters per second. No fall of water is necessary, the pressure being all-sufficient.

Lippmann has published *in extenso* his important memoir on the relations between electric and capillary phenomena. In it he establishes the following important laws: First, the capillary constant at the surface of separation of mercury and dilute sulphuric acid is a function of the electric difference which exists at this surface; and, second, when by mechanical means a liquid surface is made to change its form, the electric difference of this surface varies in such a way that the superficial tension developed in virtue of the first law opposes the continuance of the movement. These laws he has ingeniously applied, first, to the accurate measurement of capillary constants, hitherto so uncertain; and, second, to the measurement of electro-motive force by means of his capillary electrometer. His ingenious electro-capillary motor, which shows the direct conversion of electrical into mechanical energy by means of capillarity, is also fully described.

Terquem has published an historical note, in which he calls attention to the fact that the generally received notion that Faraday was the first to liquefy the gases is incorrect, since Guyton de Morveau in 1799 liquefied ammonia gas in a bath of calcium chloride and snow.

Exner has made some quantitative experiments on the penetration of liquid films by gases. He finds that the velocities of diffusion are directly proportional to the coefficient of absorption of the gas for the liquid composing the film, and inversely proportional to the square root of the density of the given gas. Adopting air as the unit of comparison, the relative velocities are—for nitrogen, 0.06; oxygen, 1.95; coal gas, 2.27; hydrogen, 3.77; carbonous oxide, 47.1; hydrogen sulphide, 165; ammonia, 46,000. As to the absolute velocity, Exner finds that 1.88 c. c. of hydrogen and 0.55 c. c. of air diffuse simultaneously through each square centimeter of the soapy film.

G. von Liebig has contrived an exceedingly useful modification of Frankland's apparatus for gas analysis, in which the measurements are made, not by measuring the volume under equal pressures, as is common, but by measuring the pressures, the volumes being made equal. It is simple in construction, satisfactory in operation, and accurate in its results.

ACOUSTICS.

In Acoustics, Lissajous has described in the *Bulletin de la Société d'Encouragement* an elaborate machine for tracing mechanically the curves which represent the composition of vibratory movements, constructed by Froment. The driving-shaft carries toothed wheels, gradually increasing in size from right to left. Upon the pinions driven by these, which are arranged in pairs, are eccentrics, which by means of connecting rods give a differential to and fro motion to an arm transverse to their direction. To the centres of two contiguous arms two other connecting rods are attached, which move a transverse arm of the second order, and similarly an arm of the third order is thus moved, which carries the style. The motion of the style is therefore the algebraic sum and resultant of the motion of the eight driving-wheels, and the curves it describes may be exceedingly complicated.

Schuller has contrived an apparatus by which Lissajous's figures may be readily produced on the screen. It consists of two pendulums, adjustable by sliding weights, carrying mirrors, each movable on a horizontal axis, at their upper ends. The planes of vibration may be parallel or perpendicular, at will. The same physicist has devised a modification of the common form of this experiment with tuning-forks. Instead of having a mirror on the extremity of a prong of each fork, he places the two forks with their four prongs in the same plane, one of the forks being vertical, and four or five inches in advance of the other, which is horizontal. The lower prong of the horizontal fork carries a screen with a small hole in it. The second fork carries on one of its prongs a small lens of short focus. The small opening in the screen is strongly illuminated by sunlight concentrated on it by a lens; an image of this is formed on a distant screen by means of the lens on the second fork. When the first fork is vibrating, a vertical line of light will appear; when the second is in motion, the line will be horizontal; when both are in action, the Lissajous curve corresponding to their rate will be given. The figures are much larger made in this way.

Decharme has given a novel method of producing sonorous vibrations. He simply blows a current of air through a tube, the lower end of which is just even with the surface of mercury contained in a suitable vessel. This yields a distinct sound, and at the same time the mercury is thrown into circular waves, producing a symmetrical network on its surface. The smaller the interior diameter of the tube, the more acute and feeble the sound and the finer the waves. He recommends, as the best, tubes between 0.8 and 5.0 millimeters in interior diameter, fixed vertically, and supplied by a uniform current of air. By having a series of properly selected tubes, the surface of the mercury may be made to assume any sets of waves and interferences; and by illuminating them strongly, they may be projected on a screen as an admirable lecture experiment. The same author has described a new form of sonorous flame. When gas under the ordinary pressure is burned from an opening three to five millimeters in diameter, a flame thirty to fifty centimeters in height is obtained. If now, by means of a similar tube held horizontally, a moderate current of air be directed against the flame, persistent and very varied sounds are produced. The experiment succeeds very well with a Bunsen burner giving a luminous flame (its air-openings being closed), the tube supplying the air being placed horizontally a little above the orifice and in contact with the flame. The phenomenon acquires special interest when viewed in a revolving mirror. In a subsequent paper he gives experimental reasons for believing that the air which is blown against the flame, and which he supposed to act solely mechanically, plays also a chemical part. He finds that, using a Bunsen burner, the sound is extremely feeble unless the air-openings be closed and the flame be luminous. Moreover, neither carbon dioxide nor nitrogen gases will produce the sound unless oxygen be mixed with it. The author hence believes that the sound results from the small explosions which are incessantly produced by the combination of the oxygen of the air with the carbon and hydrogen of the flame when the combustion of this is already incomplete. That the sound should be well-pronounced, therefore, the presence of air or of oxygen mixed with some inert gas is necessary.

Bresina has described a simple method of comparing the rates of vibration of two sounding air columns by means of oscillating flames. To the jets supplying two ordinary singing tubes are affixed lateral branches, by which the gas from each may also be supplied to a second burner supported on a convenient lateral stand. When the flames in the tubes sing, those outside vibrate in unison with them; and by means of a revolving mirror the ratio of the two may easily be ascertained by counting. If the two singing flames are connected to the same exterior flame, the combined vibration is seen in the mirror.

Tyndall, in a communication to the Royal Society on acoustic reversibility, discusses the curious results obtained at Villejuif and Montlhéry in 1822, when cannonading at the latter station was heard at the former, but not the reverse, and concludes that Montlhéry must have been surrounded by a highly diacoustic atmosphere, while Villejuif was in an atmosphere acoustically opaque. He supports this position by ingenious experimental evidence.

Mercadier has printed a paper upon the law of the influence of the variation of the dimensions of a tuning-fork upon its vibrations, in which he shows that the number of vibrations is independent of the breadth, is directly proportional to the thickness, and is inversely proportional to the square of the length. From these laws it becomes possible to calculate within one or two per cent. the dimensions of a fork necessary to give any required number of vibrations.

Neyreneuf has shown very beautifully the oscillatory or vibratory character of the detonation of a mixture of oxygen and hydrogen gases. In a tube the result may be shown in two ways: either by making the tube perfectly dry inside, in which case the watery vapor produced by the combustion condenses preferably on the cooler parts of the tube, leaving those parts transparent which the vibrating flame has heated, or by coating the tube interiorly with a thin layer of paraffin, when the melting of this substance shows the heated portions. In these experiments it is necessary to graduate the rapidity of the combustion to the size of the tube. With a test-tube an inch and a quarter in diameter and eight inches long, well dried, and filled with a mixture of equal volumes of hydrogen and air, the striæ represented fern leaves. With tubes of less diameter, the effects are more regular, especially if during the detonation there is a musical sound produced. Fine striæ are then observed perpendicular to the axis of the tube. If the tube is very long, there is no musical sound produced, but the rings are widely separated and very sharp.

La Cour has devised a very ingenious use of the tuning-fork for transmitting signals on telegraph lines, which promises to become of great importance. It is based on the well-known fact that if a given fork be made to interrupt an electric circuit by its vibrations, and the intermittent current thus produced be passed through a series of electro-magnets, each in connection with a fork of different rate, only that fork will be thrown into vibration which is in unison with the first one. Practically the time required to do this is a small fraction of a second. The advantages of this method are numerous. Not only may many receiving instruments at one station be operated, each by its own key, through a single wire, but many different stations in the same circuit may be operated, that one alone receiving the message which has the requisite instrument. Moreover, many signals may in this way be transmitted over the same wire at the same time, and many dispatches sent simultaneously to as many stations. All this may be done, too, without affecting the line for its ordinary use, and independent of atmospheric and terrestrial currents. The system recently patented by Elisha Gray, of Chicago, is essentially similar in principle.

Mayer has published a redetermination of the durations of the residual sonorous sensations, in which he was assisted by Madame Emma Seiler and her son, Dr. Carl Seiler, of Philadelphia, well known in connection with similar researches of Helmholtz. It now appears that Ut_1 has a persistence of $\frac{1}{26}$ of a second, Ut_2 $\frac{1}{46}$, Ut_3 $\frac{1}{70}$, Sol_3 $\frac{1}{102}$, Ut_4 $\frac{1}{130}$, Mi_4 $\frac{1}{153}$, Sol_4 $\frac{1}{186}$, and Ut_5 $\frac{1}{180}$ of a second. The determination is not an easy one, owing to the production of secondary and resultant tones.

Pole has made an experimental determination of the change in the pitch of a note which takes place when the sounding body is moving—a repetition of the experiment of Buys Ballot. He used for the purpose locomotive whistles, and concludes that the most common interval by which the tone is lowered when two trains pass each other is a third, either major or minor, corresponding to a speed for each of between thirty-five and forty miles an hour.

HEAT.

On the subject of Heat, Cailletet has further studied the effect of pressure on combustion, the experiments being made up to three hundred atmospheres. He finds that while the luminosity of a flame increases under pressure, the activity of the combustion actually diminishes; the temperature augments, but the oxidation lessens. An alcohol flame, ordinarily so pale, becomes as bright as that of a candle at twenty atmospheres. A candle flame under these conditions gives more light, but the wick soon becomes smoky from imperfect combustion—that which is gained on the one side being lost on the other.

Violle has called attention to the thermo-diffusion experiments of Feddersen and Dufour (which are properly such, since the diffusion of a gas through a porous diaphragm causes a rise of temperature on the side of the entering gas, and a difference of temperature on the two sides of such a diaphragm causes a diffusion of gas), in order to explain an experiment of Dufour, in which he used air in different hygrometric states on the two sides of the diaphragm, and observed the diffusion. Violle believes that the true explanation of this result is to be found in Merget's experiments, in which a porous cell, filled with pumice in fragments, and closed by a cork through which a tube passes, the whole being well moistened, develops, when exteriorly heated to a dull red heat, simply from the surface evaporation, a pressure of air in its interior of three atmospheres. Experiments of his own show how extremely sensitive is this apparatus to changes of temperature. The practical importance of these facts is very great. Our clothes, the stones of our houses, the very soil itself, when heated after previous moistening, act exactly like the apparatus of Merget, with an activity truly surprising. In animals this gaseous movement plays its part in respiration; but in plants, especially in aquatic plants, it is seen in full activity, *Nelumbium speciosum*, for example, throwing from its stomata half a liter of air per minute, solely through this action going on in its leaves.

Berthelot has published an important research, in which he has studied the thermal changes produced when acids or alkalies are dissolved in water, with the expectation of solving the question of hydratation. He has also given a description in a subsequent memoir of the various pieces of apparatus which he has employed in his calorimetrical experiments. These are, a helicoidal agitator for mixing the water of the calorimeter, an *écraseur* for crushing salts and other solids in liquids, a distilling apparatus, with worm and receiver, for effecting reactions out of contact with water, an apparatus for measuring the heat of solution at elevated temperatures, a closed apparatus for the reaction of nitrogen dioxide on oxygen, and an apparatus for decomposing ammonium nitrite by heat.

Thomsen has made another series of investigations in thermo-chemistry, in which the heat of combination of manganese, zinc, cadmium, and iron has been determined. Combining these results with previous ones, it appears that for the nine metals which decompose hydrochloric acid with evolution of hydrogen, the heat of combination for every molecule of hydrogen thus evolved is, for lithium, 125,860 calories; for potassium, 123,700; for sodium, 114,380; for magnesium, 108,290; for aluminum, 79,880; for manganese, 49,360; for zinc, 34,200; for iron, 21,310; and for cadmium, 17,610 calories.

Boisbaudran has shown that a remarkable inequality of action is exerted by a given supersaturated solution upon different isomorphous bodies. A perfectly regular crystal of potassio-chrome alum, placed in a slightly supersaturated solution of ammonio-alumina alum—which had been rendered basic, so as to crystallize in cubes—was soon covered with a white octohedric envelope showing cubic facets. After a longer time the cubic facets had increased considerably, but the distances between opposite solid angles of the octohedron remained unaltered. Hence the author concludes that the solution must have been supersaturated relatively to the octohedral faces of the ammonio-alumina alum, but not relatively to the cubic faces of the same alum. In general it appears that in the phenomena of solution and crystallization, the molecular volume, the density, the relative arrangement of the similar or dissimilar atoms in the molecule, and all other causes of dissimilarity, possess their special influences.

Indeed, it may be said that two bodies not absolutely identical never exhibit strictly the same physical or chemical reactions, however closely they may in certain particulars resemble each other.

Pfaundler confirms the unequal solubility of different faces of the same crystal, remarked by Lecoq de Boisbaudran, and calls attention to his theoretical explanation of it, first published in 1869. He concludes that those faces of a crystal which possess favorable conditions for resisting the impact of the moving molecules are preserved and grow at the expense of the others. "Thus," he says, "the principle laid down by Darwin is applicable also in the world of molecules. Those forms and combinations which possess the most favorable conditions of existence are the ones which are preserved."

Boisbaudran has also shown that very low temperatures may be produced by means of the ammonia ice-machine of Carré by taking suitable precautions. If during the cooling the heater be surrounded with ice-water, or, still better, with a freezing-mixture, it is possible to obtain, even with a machine holding only half a liter, the rapid solidification of several kilogrammes of mercury. After the freezing of nearly five kilogrammes of this metal in a solid cylinder, the temperature within was found to be —48°. If ice and salt be added to the water in which the condenser is placed during the heating, it is not necessary to raise the temperature of the heater so high by ten or fifteen degrees.

Guthrie has given a curious paper upon hydrates (or hydrated salts) formed at a low temperature, which he calls cryohydrates. He shows, contrary to the generally received opinion, that the minimum temperature attainable by mixing ice with a salt is very independent of the ratio of the two, and of their temperature, and of the state of division of the ice. The temperature of a mixture of ice and a salt is as constant and precise as the melting-point of ice. He observes that the cryohydrates of the nine salts which potassium, sodium, and ammonium severally form with chlorine, bromine, and iodine, are formed at temperatures ranging from —28° to —11°. Thirty-five salts were examined in this way, and it was found that the temperature at which the cryohydrate is formed is precisely that obtained by mixing the given salt with ice. In a subsequent paper he gives additional experiments upon salt solutions and attached water. He assigns the name *cryogen* to an appliance for obtaining a temperature below 0° C., and *cryohydrate* to the substance produced by the union of water with a body, this hydrate being capable of existence only below 0° C. He finds that of cryogens the best is a mixture of sodium bromide with three to six times its weight of ice finely divided, the temperature produced being —28° C. From an extended series of experiments, he concludes that "of similar salts, the one which produces the greatest cold when used in a freezing mixture unites as a cryohydrate with the fewest molecules of water." And again, "The temperature at which the cryohydrate is formed is the same as the temperature of the corresponding freezing mixture." Of special interest is the cryohydrate of ethyl alcohol, which is produced whenever a dilute alcohol is exposed to a temperature of —34° C., and has four water molecules united to one of alcohol. It separates from the liquid in crystals. Ether also forms a cryohydrate, solidifying at —2° C., and consisting of one ninth of ether. If the experiment be made in a long test-tube, the long candle-like mass, when removed, placed upright on a plate, and lighted, burns with a non-luminous flame, the heat being consumed in melting the ice.

Chaumont has experimentally investigated the question of ventilation, so far, at least, as the amount of air necessary for health is concerned. His determinations were made on the air of barracks, of prisons, and of hospitals; and he concludes from them that 85 cubic meters (3000 cubic feet) of air per head per hour is necessary in health, in ordinary diseases one third more than this, and in serious diseases and epidemics even more still.

Gernez has made an exhaustive research into the phenomena attending ebullition. His paper opens with a long historical note upon this subject. Then follows his own results, in which he studied (1) liquids heated in contact with solids, (2) within other liquids, and (3) the ebullition developed by mechanical action. He maintains that ebullition is an evaporation into some gaseous atmosphere contained within the liquid.

Troost and Hautefeuille have made a calorimetrical investigation on iron and manganese silicides. They conclude, first, that silicon in combining with manganese evolves considerable heat, and hence that the compound thus formed is very stable—a fact already proved for carbon. Second, that the similarity of these two substances, carbon and silicon, appears also when their action on iron is considered; they both act as if they were dissolved in the metal.

Kundt and Warburg have obtained an interesting result in investigating the specific heat of mercury vapor. On the kinetic molecular theory of Clausius, the quotient of the specific heat of a gas at constant pressure, divided by the specific heat of the same gas at constant volume, should be 1.67, while, in fact, for most gases this quotient is only 1.405. Clausius explains this by the fact that molecules are not material points, but are composed of atoms; and only in a monatomic gas would there be a correspondence with theory. The molecule of mercury is shown by its vapor density to be monatomic; and it is now found by experiment that in the case of this vapor the above quotient is actually 1.67. Hence a molecule of mercury, so far as its theoretical and mechanical properties are concerned, acts like a material point.

Desains has continued his researches upon solar radiation, and has determined the quantity of heat received per minute at Paris by one square centimeter of the earth's surface placed normal to the direction of the rays during an entire year. The maximum was on June 22, when the amount received was 1.29 units, and the minimum on January 30, the amount being one unit. He finds also that the proportion of the solar rays transmitted by a layer of water eight millimeters thick reached its maximum on July 4, being 0.71, and its minimum on April 25, being 0.63.

Mayer has proposed a simple mode of obtaining thermographs of the isothermals of the solar disk by the use of Meusel's double iodide. Thin paper, smoked on one side, is covered on the other with the iodide, and is exposed to the sun's image, formed by a telescopic object-glass, the aperture being at first only that necessary to give the smallest area of blackened iodide with a sharp contour. This he calls the area of maximum temperature. On enlarging the aperture, the black area gradually extends, forming a series of new isothermal lines with the successive enlargements. Some interesting conclusions have already been reached, and it is the author's intention to make a thorough investigation of the vast field thus opened.

Lundquist has given the results of his calculations to determine the distribution of heat in the normal sun spectrum, founded on certain measurements of Lamansky's. He represents the intensity of this heat graphically, and gives curves in which the ordinates represent intensities, and the abscissas wave lengths. It appears from these curves "that in the normal spectrum of the sun the maximum of heat is situated about in the middle of the luminous spectrum, and diminishes on both sides of this point," thus confirming entirely the experimental results obtained by Dr. John W. Draper in 1872. In the electric spectrum, however, assuming Tyndall's results as data, calculation gives a curve in which the maximum of heat is near the line A. In this case the distribution of heat is not equal in both halves of the visible spectrum.

Hoorweg has repeated with great care the experiments of Tyndall and Magnus upon the diathermancy of moist air, with a view to reconcile the discrepancies in their results. The general arrangement of the apparatus was similar to that used by Wild, a Leslie's cube being placed on either side of a Melloni's pile furnished with its conical reflectors. But for the introduction of the moist air between the cube and pile on the one side and the dry air on the other, two cylinders were used, the one filled with moistened pumice, the other with calcium chloride. These were placed beneath the line joining the pile with the source of heat, so that, whenever a current of air was driven through them, moist air rose at one end of the pile and dry at the other. With a very delicate galvanometer no deviation could be detected. A pair of tubes, each 25 centimeters long, open at the ends, and bored laterally with fine holes, was then substituted, but with scarcely an appreciable result. Both tubes were now placed on the same side of the pile, and a slight but distinct deviation was observed, amounting to 1.7 per cent. The tube was now increased to a meter in length, a heated copper plate being used as the source of heat. The absorption of moist air was 2 per cent. The experiments were repeated with various sources of heat; the absorption by moist air varied from 3 to 0.4 per cent. Alcohol vapor absorbed, under like conditions, from 6 to 27 per cent. of the heat. Hoorweg concludes with Tyndall that aqueous vapor has an appreciable absorbing power for heat, though it is much less than Tyndall supposed. The controversy between Tyndall and Magnus was a very natural one, Tyndall, on the one hand, having overestimated this absorption through neglecting condensation, or vapor-hesion, as Magnus called it; and Magnus, on the other, having denied its existence because the tube he used was entirely too short to make it apparent with the galvanometer employed in his experiments.

OPTICS.

In Optics, Crookes has published some curious and delicate experiments, in which carefully suspended disks of pith were set in motion in vacuo, apparently by the action of light. In a public lecture, however, given in Edinburgh, Professor Dewar, after explaining the method adopted by Professor Tait and himself for obtaining very perfect vacua by taking advantage of the power that charcoal has of condensing gases, stated that these vacua were so perfect that it was impossible to force through them an electric spark between electrodes one quarter of an inch apart, even when a powerful coil is employed; and hence that such vacua were, therefore, eminently proper to repeat the investigation recently made by Mr. Crookes upon the action of a beam of light on a disk at the end of a delicately suspended glass fibre. Such an investigation has been made by Dewar, and he finds that the movements of the disk are due entirely to radiant heat, and not to any mysterious agency, as Mr. Crookes seems to imply. The sensitiveness of the disk increases with the perfection of the vacuum. The sides of the glass receiver must be quite thin. If the disks are covered with lampblack, they are affected much sooner than if left white. The conductivity of the suspended body for heat, and the nature of the residuum gas within the vacuum, determine the density of the gas corresponding to the neutral point observed by Mr. Crookes. The intensity of the movements of the disk increases in proportion to the inverse square of the distance of the source of radiation. If we interpose between the light and the disk a substance opaque to heat rays, although transparent to light, the movements of the disk immediately cease. If we interpose a substance transparent to heat, but opaque to light, the deflection of the disk is large. If two disks are taken, one of rock-salt and the other of glass, it is found that the rock-salt is inactive when a beam of light is thrown on it, but the glass disk is active, the reason being that the rock-salt is not heated, whereas the glass is heated. To show the sensitiveness of the apparatus, it may be stated that an ordinary lucifer-match will, at a distance of four feet, produce instant action. Professor Dewar has not accepted the suggestion of Reynolds that the action is due to the evaporation of some of the fluid on the surface of the disk. These phenomena allow of a very perfect explanation, according to the principles of the kinetic theory of gases and the mechanical theory of heat, according to which the particles of gas are flying about in all directions with a velocity which depends upon their temperature; the length of the path of each particle is dependent principally upon the barometric pressure. Under ordinary barometric pressure of thirty inches, the length of the average path is about one ten-thousandth of a millimeter, but when the barometric pressure is reduced to the one-millionth part of an inch, the average length of the path between two collisions is about eighteen inches. If, therefore, Mr. Crookes's disks are in such a vacuum, and heated by radiation on one side warmer than on the other, the particles of gas that impinge on that side of the disk leave it at a higher temperature, and therefore with a greater velocity, than those striking the opposite side. Hence there is a recoil of the disk as observed by him.

Wibel has made additional experiments upon the cause of the luminosity of flames. He finds the results of Knapp confirmed, that nitrogen, hydrogen chloride, carbon dioxide, and other indifferent gases, act like air to destroy the luminosity of gas used in a Bunsen burner; but he also finds, curiously enough, that this luminosity may be wholly or partially restored by heating the tube to redness through which the mixture passes. Hence he concludes, 1st, that the absence of luminosity in a Bunsen flame is not due to dilution of the gas; 2d, that it is due to the cooling effect of the inert gas, since, if this be heated, the luminosity returns; 3d, that the luminosity of a flame depends upon the temperature existing in its interior; and, 4th, that ordinary illuminating materials are such because the rising gases and vapors are sufficiently heated in the exterior combustion zone to cause their decomposition.

Gariel has described some simple apparatus for explaining by construction the elementary laws and formulas of optics.

Cornu has communicated to the Academy a valuable paper on the velocity of light, in which he gives the results of the new measurements made between the Paris Observatory and the tower of Montlhéry, twenty-three kilometers distant, under the direction of the council of the observatory. As a mean of 504 experiments, he finds the velocity of light *in vacuo* to be 300,400 kilometers, or 186,700 English miles, with a probable error below one thousandth in relative value. This gives for the solar parallax, as found by the equation of light, 8.878″, and by the phenomena of aberration, 8.881″.

The same author has described a new measuring instrument for minute quantities, called a reflection lever, which consists of a beam like a balance beam standing on four points, two on the line where the knife edge is usually placed, the other two at the ends of the beam, all four being accurately in one plane. To the centre of the beam is attached transversely a mirror, by means of which any displacement from the horizontal may be detected and measured by the reflected image of a distant scale. The readings are made with a telescope.

Pickering and Strange have investigated photometrically the amount of light absorbed by the sun's atmosphere. By means of a *porte lumière* carrying a black mirror and lens, an image of the sun 40 centimeters in diameter was thrown on a screen 230 centimeters from the aperture. A circular hole was cut in the screen, and behind this the photometer disk was placed. By moving the mirror any portion of the sun's image could be thrown on the photometer, and its light measured. The results were thus given: The probable error does not exceed one per cent., except close to the edge. The light at the edge is about 0.4 that at the centre. The variations in brightness are nearly those which would be produced by a homogeneous atmosphere whose height is equal to the sun's radius, and its opacity such that only twenty-six per cent. of the light is transmitted. There appears to be a slightly different distribution of the light along the polar from that along the equatorial diameter. If the sun's atmosphere were removed, the brightness of the sun's disk would be uniform, and 3.83 times that of the centre of the disk at present. Moreover, the total amount of light would be increased 4.64 times.

Curtis has published a method of showing the phenomena of extraordinary reflection. Upon a horizontal circular stage, movable around the axis and adjustable in height, a crystal of Iceland spar well polished is placed. A beam of light falls on the crystal at such an angle that after refraction and reflection within it the beam shall pass from it, making the same angle on the other side of the normal. Five images of the opening through which the beam of light comes will be seen, one formed by reflection at the upper surface, and the other four by double reflection within the crystal.

Williams has made a photometric investigation into the intensity of twilight when the sun is at various distances below the horizon. The percentage of error in the instrument employed was about three. The results of the photometer readings were reduced to the light given by a standard candle as unity, when burning at a distance of one meter from the disk. By a graphical construction of the actual results a curve was obtained, and a table deduced which gives the percentage of light, compared with that at sunset as unity, for any number of minutes after sunset up to 34. At 1 minute it is 0.95; at 10 minutes, 0.290; at 20 minutes, 0.064; at 30 minutes, 0.009; and at 34 minutes it is 0.004.

Crosby, also, in the Massachusetts Institute of Technology, has made some photometric determinations of the light of the sky at different distances from the sun, adjusting the mirror and lens which were employed so that the sun's image would fall on the disk, and then measuring the intensity of the light at regular intervals thereafter. In some cases this method was reversed. The results represented graphically show a logarithmic curve, when the intensities are taken as ordinates and the natural sines of the sun's angular distance as abscissæ. The author calls attention to the meteorological importance of his results.

Giraud-Teulon has discovered a new method of measuring distances optically, and has constructed a telemeter based upon it. A double image of the object is produced by a division of the eye-piece, one half moving by the other by means of a micrometer screw. The apparent size of the object is measured from two stations on the same line with this object, and by a simple calculation, knowing the distance between these stations and the focal length of the telescope, the distance of the object is obtained. The error in the measurements made does not exceed five per cent.

Jacques has determined, in the laboratory of the Massachusetts Institute of Technology, the percentage of light transmitted through glass plates placed both perpendicularly and obliquely to the ray. The plates were ordinary window-glass carefully cleaned. The original light being 100, one plate transmitted 89.5 per cent., four plates 69.3 per cent., seven plates 55 per cent., and ten plates 45.3 per cent. When the plates are oblique to the ray, the amount transmitted by one plate decreases rapidly with the obliquity, while with ten plates it actually increases until the obliquity reaches 55°.

Cornu has proposed a very simple mode of correcting telescopic object-glasses for photographic rays, by separating more or less from each other the lenses composing them, an idea originally suggested by Sir John Herschel for restoring overcorrected objectives. Since the focal distance for chemical rays is about one-half per cent. of the principal focal distance behind that for luminous rays, the necessary correction is effected by separating the flint and crown components by this amount, and then carefully adjusting. Cornu has used the method with success on an object-glass of four inches' aperture; the method of Rutherford is, however, to be preferred for glasses much larger than this.

Pickering and Williams have investigated the foci of lenses placed obliquely, from which it appears that even the most carefully corrected lenses may still be defective in this respect. In a photographic camera, for lines passing through the axis, the surface, instead of being plane, should have a radius of curvature of only 0.3 the focus, while for lines perpendicular to these the curvature should be 0.7 the focus. Curiously enough, the actual curvature in the normal eye is about 0.5, or the mean of the above numbers.

Krüss has described a new eye-piece formed of a divergent flint lens, placed between two convergent lenses of crown, so that the faces in contact have the same radius of curvature, and consequently touch at all points. Of the four radii of curvature present, the first is +5.27 lines, the second +10 lines, the third +2.9 lines, and the fourth —5.73 lines. The sign plus refers to curves having the convexity toward the eye of the observer. This eye-piece has been constructed by Steinheil, and is sensibly aplanatic and achromatic, with a field of about thirty degrees.

Merz has described a new telescope which he has just completed for the observatory at Quito. It has a clear aperture of 9 Paris inches, and a focal distance of 116.75 inches. The position circle is divided directly to five minutes, and reads with a vernier to one minute. A double-ring micrometer and a filar micrometer are attached, the latter having eight eye-pieces, magnifying respectively 105, 160, 245, 350, 455, 585, 780, and 910 diameters. The hour circle is 18 inches in diameter, and the declination circle 20 inches; the former is divided to one minute, and reads to two seconds of time; the latter is divided to five minutes, and reads to four seconds. A number of improvements in the mounting are noticed.

Rayet has published a paper on the conical solar dials of the ancients, particularly that of Heracleus of Latmos, with a view to bring to light the amount of knowledge possessed by their constructors. The interior surface of these dials constituted a cone, the section of which by the upper horizontal surface was a curve of the second degree, either an ellipse (as in the dial of Heracleus and the Naples dial), a hyperbola (dial at Athens), or a parabola (Phœnician dial). The latter curve requires that one of the generatrices of the cone should be rigorously horizontal, and has been only once observed. But the dials were not made in this way: the cone was traced with any convenient proportions, subject only to the condition that its summit should be on a perpendicular from the centre of the base.

Professor Mayer has called attention to a curious bit of history in relation to Young's theory of colors. It appears that Young first adopted red, yellow, and blue as the primary colors, and that subsequently, taking it for granted that Wollaston was correct when he asserted four natural divisions of color in the solar spectrum, separated from each other by dark lines, he adopted red, green, and violet, these being the divisions noted by Wollaston. Moreover, Young seems never to have made any experiments to test his theory until some time after he had, on theoretical grounds, adopted it.

Bunsen has given an account of some new methods in spectrum analysis, in which he has sought to render the use of the spark for obtaining spectra as easy and as general as that of the gas-flame. The first portion of his paper is devoted to a description of the battery coil and spark apparatus required; the second gives the results of his investigations in this way, particularly with the rarer elements. The memoir is accompanied by three spectrum plates, uncolored, showing the spectra of thirty elements and compounds.

Watts has described a new form of micrometer for use with the spectroscope, in which one of the lines of the spectrum itself is substituted for the cross wires. This line may be the sodium line, which is almost always present in gas-flame spectra, a hydrogen line with vacua tubes, or a Fraunhofer line in solar work. This standard line is displaced by a micrometer screw, by which the amount of motion necessary to move it from one point of a spectrum to another may be ascertained. The micrometer screw is attached to the upper half of a divided line placed between the prism and the observing telescope, and moves this half over the lower, which is fixed.

Lockyer and Roberts have investigated the absorption spectra of metals volatilized by the oxyhydrogen flame. They employed a block of lime, in which the metal to be examined was placed, and in which it was volatilized by the oxyhydrogen jet. Through a tube cut in the block the beam of electric light passed, which was viewed by the spectroscope placed opposite. In this way the absorption produced by the metallic vapor could be observed. They conclude that in passing from the liquid state to that of perfect gas the molecules pass through different orders of complexity, this complexity being diminished by the action of heat, so that each molecular simplification is marked by a distinctive spectrum.

Goldstein has made some investigations upon the spectra of rarefied gases, which seem to contradict the views of Wüllner. But the latter physicist, in replying to the statements of Goldstein, claims that his view, that a line spectrum is the result of the ignition of a single line of molecules, and that a band spectrum appears when the light comes from a thick layer of the gas, is not only not disproved, but is actually confirmed by the new experiments.

Lockyer has read a paper before the Royal Society upon his new map of the solar spectrum, the portion now presented being that extending from wave-lengths 39 to 41. It is constructed on four times the scale of Ångström's "Spectre Normale," the number of lines being increased—over this, which contains but 39—to 518, of which 416 have been actually identified, and the largest number of these, 163, assigned to cerium.

Wright has experimented to obtain the spectrum of the gaseous matter evolved from meteorites when heated in a vacuum. The meteorites employed were three in number —those from Texas, from Tazewell County, Tennessee, and from Arva, Hungary. Borings from each of these were placed in a hard glass tube connected with an efficient Sprengel pump. By means of a T tube an ordinary Plücker vacuum tube was also connected with the tube to be heated. At a red heat the Texas iron gave off 4.75 times, the Tennessee iron 4.69 times, and the Hungary iron more than 44 times its volume of gases, which the spectroscope showed to consist of hydrogen, carbonous and carbonic oxides.

The same physicist has published a preliminary note on the spectroscopic examination of gases from a stony meteorite which fell in Iowa on February 12. The small grains of iron which it contained yielded several times their volume of gas, even on raising the temperature but slightly. Of this gas the two oxides of carbon constituted forty-nine per cent. (carbonic acid thirty-five, and carbonic oxide fourteen), the remaining fifty-one per cent. being hydrogen. The spectrum exhibited, the gas being under only a few millimeters' pressure, was that of carbon, especially the three brightest bands in the green and blue. This fact is especially significant when we remember that these are precisely the bands observed in cometary spectra, the close connection of meteors and comets being well established.

In a later paper upon the gaseous constituents of this meteorite, he formulates the following conclusions: 1. The stony meteorites are distinguished from the iron ones by having the oxides of carbon, chiefly the dioxide, as their characteristic gases, instead of hydrogen. 2. The proportion of carbon dioxide given off is much greater at low than at high temperatures, and is sufficient to mask the hydrogen in the spectrum. 3. The amount of the gases contained in a large meteorite, or a cluster of such bodies serving as a cometary nucleus, is sufficient to form the train as ordinarily observed. 4. The spectrum of the gases is closely identical with that of several of the comets.

Montigny has discovered, by means of an ingenious apparatus which he calls a scintillometer, a connection between the variations of color of scintillating stars and their spectra. In every case those stars which scintillate or twinkle least are those whose spectra show numerous well-pronounced lines, sometimes united in zones.

Capron has examined with a spectroscope especially constructed for the purpose the spectrum of the aurora, and has compared it with that of hydrogen, oxygen, oxides of carbon, coal gas, air, hydrogen phosphide, iron, and mercury under various conditions. He differs from Angström in his conclusions, first, as to the presence of moisture in the auroral regions, and, second, as to the importance of the violet pole spectrum in air.

Huggins has sent to the Royal Society a note on the spectrum of Coggia's comet, which presented in the spectroscope three distinct spectra: (1) a continuous spectrum coming from the light of the nucleus; (2) a spectrum consisting of bright bands; and (3) a continuous spectrum accompanying the gaseous spectrum on the coma, and representing almost entirely the light of the tail.

Lubarsch has published a paper on fluorescence, in which he concludes from his investigations (1) that for each fluorescent substance there are only certain rays of light causing fluorescence; (2) that the color of the fluorescent light depends on the rays of incidence, and follows Stokes's law; and (3) that the most refrangible fluorescent rays produced by sunlight correspond to that place in the spectrum where the liquid shows its maximum of absorption, provided its fluorescence proves a simple one when examined by prismatic analysis of the linear spectrum.

Mascart has made some very delicate experiments on the effect of the translatory motion of the earth on the refrangibility of light, in continuation of those made by Arago, and with reference to Fresnel's theory. His apparatus was arranged underground, so as to be free from diurnal thermal changes. The collimator was turned to the west, so that at mid-day and at midnight the rays entering it would be moving, the one with the earth in direction, the other opposed to it. A very numerous series of observations showed that the change of deviation thus produced is entirely inappreciable, and this with a perfection of methods which would detect a twentieth part of that which Fresnel's formula supposes. Indeed, in using mixed films, for example, Mascart shows that the length of the apparent paths of the interfering rays is not changed by this condition by one two-hundred-thousandth part, that in observing Newton's rings it is not one four-hundred-thousandth, and that in the fringes produced by double refraction there is not produced by the movement of the earth a change in the path of the two rays of one-millionth part.

One of the most valuable optical discoveries of the year is that made by Wolcott Gibbs, of a new physical constant, which he calls the "interferential constant." It is well known that when interference colors are viewed through a prism a series of dark bands appears in the spectrum, known as Talbot's bands. The number of these bands between any two lines in the spectrum may be calculated when we know the thickness of the plate producing the interference, the indices of the given spectrum lines, and their wave-lengths. If now the thickness of the plate be made unity, and the formula thus modified be divided by the density of the substance composing the plate, an expression will be obtained of a quantity called an "interferential constant." It represents the number of bands in the spectrum between two rays whose indices are given, for a thickness of the plate equal to a unit of density. This number is for each chemical substance a characteristic optical function, and independent of the temperature. Its value will apparently be fully equal to the other physical methods of analysis, such as density, boiling point, specific volume, rotatory power, etc., while in some examples given it finds important application in quantitative analysis. Moreover, it appears that the interferential constant of a compound may be tolerably well calculated from those of its constituents.

Descloizeaux has published an elaborate paper on the doubly refractive properties of the triclinic feldspars—albite, oligoclase, labradorite, and anorthite; in which he shows that, though so difficult of exact determination by present physical or chemical means, these feldspars may very readily be distinguished from each other by their optical characters.

Nodot proposes to use either sugar, potassium bichromate, or tartaric-acid crystals in place of aragonite for exhibiting the phenomena of conical refraction. The two former crystals are cut without difficulty, since a natural face of the first and a cleavage face of the second are normal to one of the optic axes. But with tartaric acid it is necessary to get such a face by trial. One is compensated for the labor, however, by the result, a cone being obtained which, for the same thickness of plate, has twice the angle of aragonite.

Mach has devised a new and convenient optical apparatus for certain polarization phenomena. Above the Nicol eyepiece of an ordinary polariscope is placed a small achromatic prism. The field of view will appear, of course, uncolored, but displaced toward the base of the prism. If now the whole eye-piece thus arranged be made to rotate about a vertical axis, each point of the field becomes a circle. If now in the field a quartz plate be placed, cut perpendicular to the axis, and which is covered with a screen having a small hole in it, a circle of colored light will be seen by persistence of vision, the order of colors being in the direction of rotation or the reverse as the quartz is right or left handed. The same apparatus may be used to project the phenomena on a screen. If an unachromatized prism be used, the spectra of the polarization colors are obtained.

Adams has devised a new polariscope for examining the rings of crystals, the objects had in view being (1) to obtain a large field, (2) to secure the means of measuring both the rings and the axial angles, and (3) to be able to immerse the crystal in liquid. The peculiarity of the optical arrangement is that the crystal section is placed at the common centre of curvature of two nearly hemispherical lenses, so that its relation to these is unchanged when the crystal and lenses are rotated about any axis parallel to its surfaces and passing through this centre.

Spottiswoode has constructed a modified form of polariscope, which has some decided advantages. It consists of a Nicol's prism as the polarizer, and a double-image prism as the analyzer, the latter being so cut as to show one image in the centre of the field, the other being excentric. By rapidly rotating the analyzer, the ring image remains by persistence and displays the phenomena, usually successive, simultaneously.

Becquerel, in a research upon magnetic rotatory polarization, has extended the list of substances possessing this property, and has determined exactly the power of rotation for a given thickness of plate and a given magnetic intensity. In general, he finds that increase of magnetic rotatory power follows increase of the refractory index.

Bertin has given a notice on projecting polarization phenomena with the apparatus of Duboscq, dividing these phenomena into three classes—those requiring (1) parallel, (2) divergent, or (3) convergent light.

Riche and Bardy have reported upon the sources of illumination utilizable in photography, in which they give the results of their examination of eight different sources of light, viz., the oxyhydrogen light, the Drummond or lime light, zinc burning in oxygen, magnesium in air, a current of nitric-oxide gas burning in a globe of carbon-disulphide vapor, a jet of nitric oxide in a test-tube containing carbon-disulphide, a jet of oxygen in the same, and a jet of oxygen in a test-tube containing sulphur. The eight lights were photographically intense in the order above mentioned, the last being eight times as strong as the first.

Vogel has proposed a simple form of camera for spectrum photography, which consists simply of a box, in one side of which is fixed, by means of a cork, a pocket spectroscope. With this instrument a picture of the solar spectrum from H to D was taken on silver bromide mixed with naphthalin-red in three minutes.

MAGNETISM.

In Magnetism, Rowland has described a simple method of determining the distribution of magnetism on iron and steel bars by means of a small coil of wire one quarter to one half an inch in diameter, containing from ten to fifty turns, which he calls a magnetic proof plane. The coil being attached to a galvanometer, it is to be placed on the required spot, and when the needle is at rest it is to be suddenly removed to a distance; the momentary deflection of the galvanometer needle will be proportional to that component of the lines of force at that point which is perpendicular to the plane of the coil.

Thalen, the Swedish physicist, has written a paper on some experiments which he has made in order to ascertain the location, depth, and magnitude of mines of iron by means of magnetic measurements. By means of careful observations, isodynamic lines are constructed. Then the line which joins the two points of maximum and minimum deviation, or the magnetic meridian of the mine, gives the general direction of the ore bed. The intersection of this line with the neutral line indicates the point where it is most desirable to begin mining. Finally, the distance of this latter point from the point on the magnetic meridian of the mine where the deviation is a minimum is one half the distance of the centre of the mass of ore below the soil.

Beetz has succeeded in producing magnets by electrolysis, the iron having in one case a magnetic moment per gramme of 59, and in another of 214.

Herwig has observed that the extra-induced currents in iron wires are of remarkable intensity, and supposes it to be due to the transversal demagnetization of the iron.

Jacques, working in Professor Pickering's laboratory, has made some experiments in answer to Jamin's criticism of Ampère's theory of magnets, in which he shows not only that Jamin's experiments are not themselves fairly capable of such an interpretation, but also that, rightly interpreted, they actually sustain the theory of Ampère.

Tommasi states the curious fact that if a current of steam, under a pressure of five or six atmospheres, be blown through a copper tube two or three millimeters in diameter coiled in a helix about an iron bar, the bar becomes a magnet, and remains magnetized so long as the steam passes.

Rowland proposes the use of a very small electro-magnet placed upon the stage of the vertical lantern for showing diamagnetic experiments, and shows by theory that there is no advantage gained by the use of a larger apparatus.

ELECTRICITY.

Edlund has published a complete paper on the nature of electricity, in which he maintains with great ability the theory that electricity is identical with the luminiferous ether, and in which he deduces most, if not all, electrical phenomena from this supposition.

Mixter has called attention to the remarkable increase in length of the spark of the Holtz machine by placing a minute gas jet between the balls affording the sparks. In this way the spark, which before was less than ten inches, became more than twelve, a brass ball having only a trifling influence of the same sort.

Rosetti has investigated the action of the Holtz machine, and finds that it follows the law of Ohm completely, but that the electro-motive force and the resistance are enormous. In his instrument the electro-motive force was 57,000 volts when the atmospheric moisture was 0.35, and the resistance, with two turns per second, 2,680,000,000 ohms. From his experiments he deduced 428 as the mechanical equivalent of heat.

Mr. W. Whitehorn has communicated to the Physical Society of London some experiments on the electric conductivity of glass. He shows that, although a perfect non-conductor at ordinary temperatures, yet glass, when heated to redness, allows the electric current to pass freely. Even at the temperature of boiling water a slight amount of electricity is conveyed by it. The resistance at a temperature of 165° C. is nearly forty times that observed at a temperature of 300°. The glass used by Mr. Whitehorn contained oxides of lead, thereby making it a better insulator than other kinds of glass.

Lesueur recommends strongly the use of zinc to prevent the formation of incrustations in steam-boilers. His attention was called to the subject by observing that the brass stays of a surface condenser in a steam-vessel were reduced, after a few years of service, to a mass of spongy copper, the zinc having entirely disappeared. This having occurred repeatedly, the constructors of these condensers placed zinc in the condensers, and observed that not only was the brass no longer attacked, but the boilers supplied from these condensers were entirely free from incrustation. Direct experiments of the author's have confirmed this fact. The explanation of it he finds either in the electric current thus generated in the boiler, the zinc being positive and the iron negative, or more probably in the hydrogen continually set free in minute quantity on the iron surface, thus preventing the adherence of scale. (The author does not seem to be aware that this same device is not new, having been employed for this purpose for many years in the United States.)

Ducretet has noticed a remarkable property of aluminum when conveying a current. If in a voltameter one of the electrodes be aluminum, the other being of platinum, the former being negative, water is decomposed, hydrogen is set free at the aluminum surface, and oxygen at the platinum, the current passing freely. But if the aluminum electrode be made positive, no action takes place, and no current, or a very feeble one, passes. In the first case an electric bell in the circuit rings violently, in the second not at all. It is proposed to call a voltameter thus constructed a rheotome. It is doubtless capable of many useful applications.

Wilson has communicated a paper to the London Physical Society on a method of measuring electrical resistance in liquids, in which polarization of the electrodes is entirely avoided. A long, narrow trough is filled with the liquid to be measured, and a porous cell filled with sulphate of zinc solution is placed at one end, and a similar one containing copper sulphate at the other. In the first of these cells a plate of zinc is placed, and in the second one of copper. The external circuit is completed through a resistance coil and galvanometer. A suitable deflection is obtained at the start, and then one of the porous cells is moved toward the other. The deflection is of course increased, and resistance is introduced to bring it back to that originally obtained. This introduced resistance is evidently equal to that of the column of liquid taken out of the circuit.

Foster has given graphical solutions of a number of simple electrical problems. He prefers the method in which the ordinates represent electro-motive forces and the abscissas resistances, and has devised a simple instrument which he calls a galvanometric sliding-rule, by means of which many problems of this sort may be rapidly and accurately solved.

Amory has published a brief note on the great facility with which the horizontal pendulum of Zöllner can be used to demonstrate Ampère's laws of the attraction and repulsion of currents.

Barker has described a new and convenient form of lecture galvanometer based on the vertical lantern. Above the horizontal condensing lens of this lantern is the upper needle, suspended by a filament of silk. To this a second needle is attached by means of an aluminum wire passing through the condenser and the mirror. The second needle swings in a coil placed beneath the inclined mirror. Any current in this coil deflects the lower needle, and, of course, the upper one also. This latter only appears on the screen, together with the graduated scale beneath it.

Daguenet has proposed a simple apparatus for showing the phenomena of the spark in rarefied air. A barometer tube a meter in length has a wire of platinum sealed in at one end, and is then filled and inverted in the usual way. On connecting one electrode of an induction coil with the platinum wire and the other with the mercury, the space above the column is filled with a whitish light. By introducing air and plunging the tube in a deep cistern the spark may be observed at various pressures, and by introducing various other gases and liquids many beautiful effects may be produced.

Spottiswoode has presented to the Royal Society a memoir giving the results of his experiments on stratification in electrical discharges through rarefied gases. The experiments were undertaken to ascertain whether the stratification obtained with the continuous discharge of large batteries could not be obtained by a less expensive arrangement in an interrupted circuit. The various means adopted are given, and the peculiarities of the discharge are described. Phenomena analogous to those obtained with the coil were obtained with the Holtz machine.

Becquerel has studied the action of magnetism on the induction spark, and shows that the loud sound which is produced when the current which flows around a powerful electro-magnet is suddenly broken between the poles is due solely to the mechanical action of the magnet, the same effect being produced by a strong blast of air directed on the spark at the instant of breaking circuit.

Schrötter has proved that when the spark passes through a Geissler tube containing phosphorus vapor, the walls of the tube are covered with a thin layer of amorphous phosphorus. Moreover, if the vapor is contained between two sealed tubes, and the spark passes through the interior one, the same effect results, showing that it is due to induction.

Terquem and Trannin have described a new and convenient form of apparatus for piercing glass by the electric spark.

Pickering and Strange have given the results of their measurements on one of Farmer's large dynamo-electric machines. With a speed of 1280 revolutions per minute, a light of from 650 to 900 candle-powers was obtained.

A large Gramme magneto-electric machine was received from Paris in February by the University of Pennsylvania, at Philadelphia, which gives very remarkable results when used for producing the electric light.

Champion, Pellet, and Grenier have published a memoir upon the applications of electricity to the firing of blasts, of torpedoes, and to mining purposes generally, in which are considered the recent improvements in electromotors, in primers, and in fuses, with the various methods of using them to the best effect.

CHEMISTRY.

General Chemistry.—Some advance has been made in chemical theory. Michaelis and Wagner have shown that while two bodies having the empirical constitution of ethyl sulphite are known, yet only one of these is the true sulphurous ether, as proved by its mode of preparation. In this latter compound the ethyl groups are both united to the thionyl by oxygen, and hence the sulphur in the radical must be a tetrad. Zimmermann has made a similar research on ethyl phosphite, and comes to the conclusion that phosphorous acid is a trihydroxyl derivative of phosphorus, and that in the ether neither of the ethyl groups is directly united to the phosphorus, since in that case ethyl-phosphinic acid would appear as a decomposition product. From this theoretical position the author proceeded to prepare tri-sodium phosphite, which he obtained only as a thick sirup, but in which the ratio of the phosphorus and the sodium could be determined.

Friedel has produced a direct union of methyl oxide and hydrogen chloride—a body which, since both of its constituents can exist free, must be classed with the molecular compounds of Kekulé. But Friedel shows that this body is not decomposed when converted into vapor, and hence argues that the ordinary rules of chemical union should be extended to it. This can only be done by supposing its oxygen to act as a tetrad or its chlorine as a triad. Since hydrogen chloride and methyl chloride do not unite even at —18° to —20°, the author inclines to the former view, and supports it by other cases, such as water of crystallization—a view of the matter which was taken some years ago by Wolcott Gibbs.

Hübner has shown that benzoic acid will set nitrobenzoic acid free from its salts. As the latter is the stronger acid, the fact is an important one in chemical dynamics.

Meyer and Lecco have sought to fix the equivalence of nitrogen in ammonium compounds by an examination of the chloride of di-ethyl-di-methyl-ammonium, derived (*a*) from di-ethyl-amine, and (*b*) from di-methyl-amine. If the same chloride is formed by these two processes, then ammonium is a derivative of quinquivalent nitrogen; if two isomeric chlorides result, then nitrogen is a triad in ammonium compounds. The most minute examination failed to show any difference in the bodies obtained, and hence confirms the variability of nitrogen equivalence. They afterward proved that in the higher substituted ammonias no exchange of radicals takes place within the molecule; thus answering Lossen's objection to the results they had previously obtained, which proved that ammonium chloride and its substitution derivatives were atomic and not molecular compounds, and that hence the nitrogen in them was quinquivalent.

INORGANIC CHEMISTRY.

In Inorganic Chemistry Pebal has examined euchlorine and hypochloric acid critically, and comes to the conclusion that the former is a mixture of the latter and free chlorine in variable proportions. He assigns to the latter the formula ClO_2.

Göpner claims to have shown that the so-called hydrate of chlorine is really a hydrate of a molecular union of hydrochloric and hypochlorous acids. He bases his opinion on the fact observed by him that when this hydrate acts on mercury, mercuric and not mercurous chloride results. To this view Schiff decidedly objects, both on grounds of antecedent improbability and of experimental evidence.

Kingzett has succeeded in crystallizing a hydrate of calcium hypochlorite from a saturated solution of bleaching-powder.

Reyman has detected bromoform in commercial bromine, and says it may easily be recognized by its odor, and by the fact that it lessens the solubility of the bromine in water.

Buchanan, chemist to the *Challenger* expedition, finds that sea-water, artificially cooled, crystallizes in hexagonal tables, the water from the melting of which yields 1.578 grammes of chlorine to the liter. Iceberg ice, on the contrary, gave only 0.052 to 0.1723 gramme in a liter.

Deering has noted some points worthy of notice in examining waters by the ammonia method. He observes that the tint after the addition of the Nessler solution increases constantly in depth; hence he makes a caramel solution after ten minutes to imitate the distillate, and uses that for comparison. He also notes that distilled water contains ammonia; that potable waters yield ammonia in the second, third, and fourth fractions; that commercial stick potash gives ammonia when distilled with water; and that an aqueous extract of peat gives much ammonia when distilled with sodium carbonate.

Schöne has proved the presence of hydrogen peroxide in rain and snow water collected in the vicinity of Moscow. Only four out of one hundred and thirty specimens of rain, and twelve out of twenty-nine of snow, failed to give the reaction. Quantitatively the amount in rain varies from 0.04 to one milligramme per liter. The daily maximum was reached between 12 and 4 o'clock P.M., and the annual in August. The peroxide is supposed to exist in the air both free and in solution, and in the amount of 0.000000268 c. c. in a liter.

Scheurer-Kestner has observed that the white fumes accompanying the sulphurous oxide which is produced by the combustion of iron pyrite are caused by the presence of sulphuric oxide, and that the sulphuric oxide is produced by the oxidation of the sulphurous oxide by air in presence of ferric oxide at a high temperature.

Nichols, under the direction of the State Board of Health of Massachusetts, has examined the composition of the air at different depths below the surface of the "Back Bay lands" in Boston. In three experiments, the depths being three and a half, two, and ten feet respectively, no hydrogen sulphide was detected, ammonia was found in minute quantity, and carbonic-dioxide gas existed in proportions varying from one and a half to twenty-one parts per thousand of air. This amount was approximately proportional to the depth, and reached a maximum in August and September.

The subject of nitrification in soils has been studied by Fittbogen, who has made a series of experiments on the effects of air, with various compounds of potash, lime, magnesia, and of other substances, including quartz sand, on the formation of nitric acid and ammonia in peat. The greatest gain of nitric acid was produced by carbonate of potash; carbonate of lime, caustic lime, and caustic magnesia were next in order of efficiency; with gypsum and sand less nitric acid was formed than when the peat was simply exposed to air, with no admixture. The amount of ammonia in the peat increased under the influence of air alone, but decreased in each case when mineral matters were added to the peat. Fittbogen suggests that the marked power of carbonate of potash to aid the formation of nitric acid from the nitrogen of organic compounds in the soil may explain in part the usefulness of wood ashes as a fertilizer. Their potash would not only act directly as plant food, but would also be especially efficient in furthering the change of the combined nitrogen of the soil into forms more fit for the nourishment of vegetation.

Ditte has proposed a new and simple mode of determining boric acid, which depends upon the crystallization of calcium borate when a salt of boric acid is introduced into a fused mixture of one part calcium chloride and three parts mixed sodium and potassium chlorides. This crystallization takes place upon the surface of the fused chlorides in the form of a ring on the sides of the crucible. Being insoluble in water, the calcium borate is left when the mass is treated with cold water, and may be collected on a filter, dried, and weighed.

Schnetzler has investigated the action of borax upon fermentation and putrefaction, following out some experiments made by Dumas. He finds that borax acts promptly upon the protoplasm within living vegetable cells, causing it to contract, to separate from the cell walls, and to condense. All movement is at once stopped within the cell, and the chlorophyll grains are changed in form. The cells of yeast, of mould, etc., lose their vitality in a solution of borax. Infusoria, rotifers, entomostracans, tadpoles are killed in such a solution. In the infusoria the contraction of the sarcode can be distinctly seen. Grapes and currants are perfectly preserved by borax; milk containing one grain of borax in thirty cubic centimeters remained sweet for three months; and beef was preserved for a year and a half in a concentrated solution, which was renewed three times, without the least odor of decomposition. Borax is, therefore, strongly recommended for the preservation of anatomical preparations and for dressing wounds.

Schutzenberger and Bourgeois have sought to throw some light upon the production in plants of the so-called carbohydrates by an investigation of the products resulting from the solution of white cast iron (in which the carbon is combined) when conducted at ordinary temperatures. They find that the residue obtained on treating 100 grains of this iron with a cold solution of copper sulphate is, after removal of the copper, a brownish-black pulverulent substance weighing 7.135 grains, and consisting of carbon, 64 per cent.; water, 26.10; silica, 7.1; undetermined, 1.8. It appears to be a hydrate of carbon, having three molecules of water united to eleven atoms of carbon. Nitric acid oxidizes it to a reddish-brown amorphous substance, which the authors call nitrographitoic acid.

Delachanal and Mermet have proposed a method for determining the amount of carbon disulphide contained in the alkali sulphocarbonates of commerce which are now coming into quite general use for the destruction of the phylloxera. The solution is precipitated with acetate of lead, the lead sulphocarbonate decomposed into lead sulphide and carbon disulphide by heat, the latter being carried over into sulphuric acid to retain the accompanying vapor of water, and then into a tared portion of olive-oil, where it is retained.

Heumann, in a paper upon the cause of the luminosity of flames, gives experimental evidence to prove (A) that a flame may be rendered non-luminous (*a*) by cooling it, (*b*) by diluting it with an indifferent gas, the temperature of combustion not being increased thereby, and (*c*) by energetic oxidation of the luminous matter; and (B) that the luminosity may be restored (*a*) by heating the flame, (*b*) by raising the temperature of its combustion, as by heating the gases before they burn, and (*c*) by diluting the oxygen with an indifferent gas. In a subsequent paper he asserts, contrary to the view expressed by Blochmann, that it is to the cooling of the gas by the burner itself, or by some object introduced into it, that the space between the flame and the burner or the object is due.

Laspeyres has proposed a more perfect apparatus for the direct estimation of water in minerals, etc., consisting of a series of calcium-chloride tubes, through which a current of dry air is passed, in which the substance is heated. The chloride of calcium used is dried at 150° to 200° C.

Vierordt has suggested the use of his quantitative spectrum-analysis method in volumetric assay, and gives experiments which show its very great advantages.

Volhard has aided analytical processes by describing a new swimmer for burettes, a new form of ammonia apparatus, and a new calcium-chloride tube for organic analysis.

Bach has described some simple devices for laboratory apparatus, viz., a water-blast, a wash-bottle with constant stream, and a gas cock.

Griffin describes his new form of portable gas furnace, in which a pound of cast iron can be melted in thirty-five minutes, and the new method of supporting crucibles in it.

Godeffroy has discovered that cæsium salts give precipitates readily with quite a number of metallic chlorides, thus making the reaction with antimonous chloride previously observed by him quite general. The reaction he has observed with chlorides of the following metals, all the precipitates being crystalline: iron, bismuth, zinc, cadmium, mercury, copper, manganese, and nickel. Rubidium salts behave similarly.

Nilson has made a series of experiments on the salts (particularly the selenites) of the rarer earths, with a view to determine the equivalents of the contained elements. He concludes that glucinum has an equivalence of two, and belongs to the magnesium group, while yttrium, erbium, cerium, lanthanum, and didymium have an equivalence of four, like aluminum, iron, chromium, and indium, their double atoms, also, like the latter, having an equivalence of six.

Santesson has examined a series of niobium compounds, and has minutely described the principal fluoniobates.

Hammerbacher has succeeded in discovering the presence of thallium in carnallite, though the quantity was too small to enable him to isolate it. Rubidium and cæsium were also detected by the spectroscope in this and in sylvite.

Hawes has made a chemical investigation of the trap-rocks of the Connecticut Valley. The results show that the ejected rock had originally the same composition, and hence, presumably, that wherever now found, it came in the first place from the same source, and that a deep-seated one. Subsequent action has converted the dolerite into a diabase, the principal action being upon the pyroxene, which was converted into chlorite. The chief minerals composing the dolerite are pyroxene and labradorite—sometimes anorthite—with a little chrysolite and apatite. Magnetite is also found in these traps, in some of them to the amount of nearly fourteen per cent.

Terreil has proposed a new method of producing pure nickel salts on a commercial scale without the employment of either hydrogen sulphide or ammonia. His process consists of four operations: first, solution of the nickel in acid; second, precipitation of the copper by iron; third, peroxidation of the iron, and transformation of the metals into sulphates; and, fourth, precipitation of the iron by barium carbonate and crystallization of the pure nickel sulphate.

Treve and Durassier have experimented to ascertain the relation which exists between the chemical composition of a steel and its coercitive force. They find that up to a certain limit (from 1 to 1.15 per cent. of carbon) the magnetic saturation increases with the content of carbon. Durassier gives a note of great practical value on the choice of steels for different purposes.

Hartley has given a simple mode of assaying an iron ore when the facilities of a laboratory are wanting. The ore is balanced (on a rude pair of scales without weights) against pure iron wire, both are dissolved and made up to the same volume, and one fiftieth of each is taken for titrition.

J. L. Smith has discovered, in investigating the anomalous fact that while ferric oxide as ordinarily precipitated and dried is not magnetic, the oxide thrown down from solutions of meteorites is invariably magnetic; that any solution of iron containing nickel, cobalt, or copper gives a precipitate of ferric oxide which becomes magnetic on drying. The exact cause of this action is obscure. Chandler suggests the formation of a saline oxide, analogous to the magnetic oxide of iron, with these metals.

Boussingault has published an elaborate research into the manufacture of steel by cementation, the analytical results of which must prove of great value.

Bauer has examined the action of strong sulphuric acid upon lead and lead alloys. He finds that small quantities of antimony and copper increase the resisting power of lead to this acid, but the bismuth in a lead alloy diminishes it.

Kaemmerer has succeeded in obtaining well-defined crystals of cadmium by distilling the metal in a current of hydrogen. The crystals are isometric, being octohedrons, dodecahedrons, and their derivatives.

Delachanal and Mermet have prepared a compound of platinum, tin, and oxygen analogous to the gold compound known as the purple of Cassius. When the brown liquid which is obtained when a solution of platinic chloride is mixed with one of stannous chloride is diluted with water and boiled, a brown substance is precipitated which, when well washed with hot water, contains no chlorine, but only oxygen, tin, and platinum. The authors have also prepared the same substance by placing a strip of tin in platinic chloride. Its composition somewhat varies with its mode of preparation.

Bibra concludes from his investigations that silver chloride when blackened by the action of light is not subchloride; the true subchloride, obtained by the action of hydrochloric acid on argentous citrate, having the formula Ag_4Cl_3.

ORGANIC CHEMISTRY.

In Organic Chemistry, Carnelley has shown that when the mixed vapors of carbon disulphide and alcohol are passed over red-hot copper, carbonyl sulphide, ethyl hydride, and copper sulphide are the normal products; but that the ethyl hydride breaks up into marsh gas, ethylene, acetylene, and ethyl aldehyde.

Gladstone and Tribe have continued their researches upon the action of their copper-zinc couple on organic bodies, and have studied its action on chloroform, bromoform, and iodoform. In presence of alcohol the three bodies are split up in the same general manner, acetylene and marsh gas being, in addition to the haloid zinc ethylates, the hydrocarbon products. The amount of acetylene is least with chloroform, greatest with iodoform.

Berthelot has contrived an interesting lecture experiment for showing the direct union of the olefines with the hydracids. Two flasks of about three hundred cubic centimeters' capacity are previously filled, the one with propylene gas, the other with hydrogen-iodide gas. In the lecture these flasks are opened and placed mouth to mouth, the joint between them being made tight by a band of rubber. Drops of isopropyl iodide soon appear, and the combination is complete in half an hour.

Riban has published an extended memoir on the terebenic hydrocarbons and their isomers which is of great value. He differs from Berthelot in many of his conclusions.

Bouchardat, by heating isoprene in a sealed tube to 280° –290° for ten hours, has succeeded in polymerizing it, and converting it into a terpilene closely identical with oil of turpentine.

Tilden has produced a new body by the action of nitrosyl chloride upon oil of turpentine, which he calls nitrosoterpene.

Frebault has observed that a peculiar green coloration is developed in oil of peppermint by the action of certain acids, notably picric acid, which has a red fluorescence similar to chlorophyll. He suggests, therefore, that this substance is formed in the reaction.

Barbier has investigated the hydrocarbon discovered by Berthelot, and called fluorene. By oxidation it yields diphenylene-carbonyl, and this acted on by sodium amalgam produces fluorene alcohol in hard, white, hexagonal plates. This substance is interesting as being the first alcohol which by heat alone loses water and forms an ether.

Ekstrand has prepared the hydrocarbon retene from the heavy oils obtained in the distillation of wood, and has studied its properties. It forms sulpho-conjugated acids, and by oxidation affords dioxyretistene and two other bodies, both monobasic acids.

Armstrong calls attention to some remarkable changes of certain isomers in the aromatic series into each other, effected by changes of temperature; and hence infers that extreme caution should be exercised in judging of the constitution of these bodies.

Meyer and Ambühl have succeeded in producing a compound in the fatty series analogous to azobenzol in the aromatic. When solutions of diazobenzol sulphate and sodium nitro-ethane are mixed, a yellow oily body separates, which after purification crystallizes in square orange-colored plates. It is azo-nitro-ethyl-phenyl.

Gutzeit has succeeded in isolating from the fruits of several plants sufficient ethyl alcohol to prove that this substance, hitherto supposed to be solely a result of fermentation, is a normal constituent of the unfermented juices of plants.

Renard has made some experiments on the action of electrolytic oxygen upon methyl and ethyl alcohols. Using five Bunsen elements, and 100 cubic centimeters of ethyl alcohol acidulated with five per cent. of a dilute sulphuric acid, the action being continued for forty-eight hours, he succeeded in proving the presence in the liquid of methyl formate, aldehyde, ethyl acetate, acetal, and a new body—ethylidene monoethylate. It is acetal in which ethyl is replaced by hydrogen. Sulphethylic acid was also produced in the electrolysis. Methyl alcohol thus treated yielded carbon dioxide and methyl oxide gases, besides methyl formate, methylal, and methyl acetate.

Wagner and Saytzeff have succeeded in synthetically producing a new amyl alcohol. Of the eight isomeric amyl alcohols pointed out by theory, four are primary, three are secondary, and one is tertiary. Of these, again, five were previously known; the new one now discovered is the sixth. It is di-ethyl-carbinol, of course a secondary alcohol, and is produced by the action of zinc-ethyl on ethyl formate, the reaction being foreseen by theory before it was realized as fact.

Freund has examined the asserted production of trimethylcarbinol in ordinary alcoholic fermentation, and has been entirely unable to find a trace of it in the products of distillation.

Berthelot has effected a simple dissociation of aldehyde by heating a mixture of five volumes of hydrogen and two volumes of aldehyde vapor to a red heat for half an hour. The products were carbonous oxide and methane.

Meyer has succeeded in producing acrolein by the imperfect combustion of ethylene. When to 100 volumes of ethylene gas 62 to 65 volumes of oxygen are added and exploded in a eudiometer, carbonous oxide, hydrogen, and condensed hydrocarbon gases are formed, and carbon is separated. At the same time the carbonous oxide unites to the undecomposed ethylene present, and produces acrolein. This was recognized by its well-known properties, and by conversion into acrylic acid.

Von Lang has measured the crystals of glycerin. They are brilliant when in their mother-liquid, but deliquesce in the air. In form they are orthorhombic, the ratio of the axes $a:b:c = 1:0.70:0.66$.

Von Zotta has examined more closely the production of glyceric oxide by the action of calcium chloride on glycerin. The product is an oily liquid of specific gravity 1.16, converted into glycerin again on boiling its aqueous solution.

Prevost has given a new and simple method of preparing epichlorhydrin, which consists in warming dichlorhydrin in a capacious retort attached to a receiver, and adding pulverized sodium hydrate to it in the proportion of 250 grammes to 550 cubic centimeters of dichlorhydrin, the temperature being kept below 130°. Almost pure epichlorhydrin distills over.

Clin has given a method for the preparation of crystallized monobromcamphor — being camphor in which an atom of bromine has replaced one of hydrogen—by the direct action, at 100° C., of bromine upon camphor. The specimens shown to the French Academy were magnificently crystallized.

Bourneville finds that monobromcamphor (1) lessens the number of beats of the heart, (2) lessens the number of inspirations, (3) lowers the temperature of the body, (4) possesses powerful sedative properties, and (5) produces ordinarily no disturbance of the digestive organs. It has been used with good effect in nervous affections, even in cases of long standing.

Hesse has published a valuable investigation giving the exact data concerning the rotatory power of a large number of organic bodies—including the sugars—on polarized light.

Kreusler has negatived the assertion of Raoult that pure cane sugar in aqueous solution, without the presence of air or ferments, but solely by the action of light, became inverted and yielded glucose. Solutions of various strengths were sealed up *in vacuo*, and were exposed to direct sunlight whenever possible for eleven months. Not a trace of glucose could be detected. In presence of air, however, some glucose is formed; and to this fact the author attributes the results obtained by Raoult.

Gautier has effected an important synthesis likely to prove of practical value. He has succeeded in uniting two molecules of dextrose by abstracting from them a molecule of water, thus forming a substance having the composition of the compound sugars. The result was accomplished by the action of hydrochloric-acid gas on the dextrose dissolved in absolute alcohol. A substance was obtained which was more analogous to gum and dextrin than to sugar in appearance and taste, but which yielded again a simple sugar on heating, though this appeared not to be dextrose again, but to be analogous to, if not identical with, inosite.

Giraud has given an analysis of gum-tragacanth, by which it appears that sixty per cent. of it is a pectic compound apparently identical with the pectose of Fremy, existing in unripe fruits and in turnip roots, etc. Pectic acid and pectin were both prepared from the gum. The other constituents are—water, twenty per cent.; soluble gum, eight to ten per cent.; cellulose, starch, and mineral matters, each three per cent.

Reichardt has prepared from the thoroughly exhausted beet-root pulp a new carbohydrate isomeric with Scheibler's arabinic acid, which he calls pararabin. The pulp consists of 38.5 per cent. arabinic acid, 54 per cent. pararabin, and 7.5 per cent. cellulose.

Hofmann has examined a new red coloring matter, brought into commerce within a few months under the name of eosin.

It has an exceedingly rich tint, recalling that of rosaniline, but inclining more to a garnet red. In mass it is a brown powder with a greenish metallic lustre. Upon investigation it proved to be a bromine-derivative of one of the remarkably fluorescent bodies discovered by Baeyer, and called fluorescein, obtained by the action of phthalic oxide upon resorcin. Its composition proved it to be a phthalein of dibromresorcin, and this was confirmed by its successful synthesis, by the action of bromine on fluorescein.

Benedikt has prepared phlorein by the action of nitrous acid on phloroglucin. It is a beautiful dark-green powder with a metallic lustre, dissolving in caustic and carbonated alkalies with an intense violet color. As it was found to contain nitrogen, its allies, brasilein and hæmatein (coloring matters from Brazil-wood and logwood respectively), were examined, and found also to contain it, having been heretofore overlooked in the analysis.

Liebermann has investigated the coloring matter known as emodin, which accompanies chrysophanic acid in the root of rhubarb. Distilled with zinc dust it yielded a substance closely resembling anthracene. But on treating it with acetyl oxide, a mono- and a tri-acetyl derivative were obtained, and it was shown to be a derivative of methyl-anthracene, the next higher homologue of anthracene. Further examination proved emodin to be trioxymethyl-anthraquinone.

Liebermann and Fischer, on account of the importance of the oxyanthraquinones as coloring matters, have sought to discover a method by which they could be converted the one into the other. From purpurin they prepared purpuramide; and by the action of nitrous acid on this they obtained a bioxyanthraquinone which proved to be identical with the purpuroxanthin of Schützenberger, obtained in quite a different way.

Claus has discovered in the alizarin paste of commerce a peculiar substance which dissolves to a blood-red liquid with alkalies. It crystallizes from acetic acid in large dark-brown needles with a bronze lustre. At 305° to 310° C. it sublimes, and condenses in orange needles. On examination it proved to be the dioxyquinone of chrysene, *i. e.*, the alizarin of chrysene. Hence Claus gives to it the name chrysezarin.

Stenhouse and Groves have shown that, by the prolonged action of chlorine upon pyrogallol, two new bodies are formed, which they call respectively mairogallol and leucogallol. The former is produced by a long-continued action of the gas, and crystallizes from boiling glacial acetic acid, or from mixed ether and glacial acid, in brilliant orthorhombic prisms. Leucogallol forms crystalline crusts composed of minute colorless needles.

Lorin has described a method of preparing concentrated formic acid, which consists in adding to concentrated glycerin, contained in a tubulated retort, and heated to 87°, dehydrated oxalic acid in powder, repeating the process whenever the evolution of gas ceases. The formic acid which distills over is rectified, and then contains ninety-four per cent. of real acid.

Bremer, by the action of phosphorus and iodine upon ordinary tartaric acid (dextrorotatory) in presence of water in a sealed tube, has succeeded in obtaining from it a new malic acid, which also rotates to the right. He is now experimenting upon lævorotatory tartaric acid, in the hope of producing a left-handed malic acid, and by the union of the two an inactive acid.

Carey Lea has published a valuable modification of the usual iron test for hydrocyanic acid. If a little uranic acetate be added to a solution of a ferrous salt, there is thrown down in presence of a soluble cyanide a purple precipitate. One five-thousandth of a grain of hydrocyanic acid gives, when thus treated, a perfectly distinct reaction. He also recommends the use of ammonio-ferric citrate, in connection with ferrous salts, in the Prussian-blue test. In this way one two-thousandth of a grain of potassic cyanide may be detected, a delicacy far greater than has been before claimed for this test.

The crude acids of the native petroleum of Wallachia have been examined by Hell and Medinger. The second run of the still yields to caustic soda an acid which, after solution in water and treatment with sulphuric acid, collects as an oil on the surface, and is called "mineral oil" by the workmen. This is a mixture of several acids, probably homologous, but their separation is exceedingly difficult. An ethyl-ether of one was finally obtained, whose saponification yielded the acid as a colorless liquid of specific gravity 0.982. It is a weak acid, its sodium and potassium salts being of the consistency of soft soap. It is a fatty acid, but does not belong to either of the three series of fatty acids now known.

Berthelot has observed that perfectly pure acetic oxide is not changed into the sodium salt in presence of sodium hydrate, even after the anhydride is completely dissolved. The acetic oxide, therefore, even when dissolved, may exist for some time in contact with water, and even of soda, without union. In presence of an alkali the union is much more rapid, taking place in the course of two or three minutes, whereas in the case of water it requires more than an hour.

Carey Lea publishes some experiments which show that methyl nitrate is not nearly so explosive as has been stated by Girard. It does not explode by percussion, and the explosion is feeble when the liquid is heated. Nevertheless, he thinks a few suggestions desirable on the precautions to be taken in its manufacture on a large scale.

Klippert has prepared ethyl orthosilicate very readily by the action of silicon fluoride upon sodium ethylate.

Pinner has effected a synthesis of malonic acid by boiling ethyl chloracrylate with barium hydrate for a long time. The conversion of the one into the other raises some interesting theoretical questions.

Ramsay has examined the properties of ethyl-thiosulphate of sodium prepared by the action of ethyl bromide on sodium thiosulphate. He finds that it is exceedingly unstable, decomposing spontaneously in a few weeks. The precipitates produced in its solutions by silver, lead, or barium nitrates are even more rapidly decomposed, only a few hours being required. When distilled with phosphoric chloride a complex reaction takes place, ethyl disulphide being one of the products.

Zöllner and Grete have made a series of experiments in the Royal Agricultural School at Vienna upon Dumas's remedy for the phylloxera, that pest of the grape-culture. They find that while his potassium sulphocarbonate will do the work, yet that the ethylsulphocarbonate will do it better, since, while it also evolves the effective carbon disulphide, it does not evolve the deleterious hydrogen sulphide. Moreover, it is more readily made, and is cheaper. They recommend more especially, however, the amylsulphocarbonate of potassium as being cheaper, costing only about fifteen cents per pound.

Kolbe has further investigated the fact, observed by his assistant, Ost, that while sodium silicate yields on dry distillation sodium sodiosalicylate, potassium salicylate similarly treated yields potassium paraoxybenzoate. He finds that the barium, strontium, calcium, and magnesium salts act like the sodium salt, and that the potassium salt does the same when heated only to 145°. He recommends this as the best method for the preparation of paraoxybenzoic acid. A series of papers has been published in Kolbe's *Journal* by Neubauer, Kolbe, Wagner, Fontheim, Zürn, and others upon the antiseptic action of salicylic acid. It has come very extensively into use, having, for example, entirely replaced phenol in the lying-in hospital of Leipsic.

Weiske proposes the use of salicylic acid in titrition, especially in acidimetry. A convenient quantity of it is dissolved in distilled water, and a few drops of ferric chloride solution is added. To the intensely colored solution soda solution is added to exact neutralization, the color changing to yellowish-red. If a few cubic centimeters of this liquid be added to the acid to be titered, the color becomes of a deeper violet as the soda solution is added, reaching its highest intensity just before neutralization, and becoming colorless on the slightest excess of alkali.

Knop has made a series of experiments to ascertain the action of salicylic acid upon vegetation. He finds that it has a marked depression of action upon the vegetative activity of cells, whether these be the chlorophyl cells of the higher or the non-chlorophyl cells of the lower orders of plants, provided only the acid be free. Of fifteen grains of corn soaked in water containing $\frac{1}{10000}$ of this acid, fourteen failed to germinate. Moreover, mould is prevented by a quantity of salicylic acid as minute as this.

Rautert has given an improved method of purifying salicylic acid by distilling it in a current of superheated steam. Recrystallization from water makes it snow-white.

Kolbe has thoroughly investigated the properties of his "salylic acid" obtained by reducing chlorsalylic acid with sodium amalgam, and has come to the conclusion that it is nothing but benzoic acid to which some foreign fatty substance, formed at the same time, obstinately adheres. When oxidized by potassium permanganate, pure benzoic acid crystallizes from the solution.

Hartmann, following Kolbe's lead in proving that when chlorsalylic (metachlorbenzoic) acid was reduced with sodium amalgam, benzoic acid resulted, has reduced chlordracylic (parachlorbenzoic) acid by the same means, and has also obtained benzoic acid as the reduction product.

Boussingault calls attention to the uncertainty of the guaiacum test for kirsch cordial. He states that the blue color is not characteristic, since it is developed in zwetschen or prune cordial, and does not always appear in genuine kirsch. Upon investigation, he finds that the blue coloration is due to the presence of copper, and asserts that any specimen of kirsch which is blued by guaiacum will give with potassium ferro-cyanide a red precipitate of copper ferro-cyanide.

Weith has shown that, by the action of ammonium chloride on methyl alcohol, there is produced both tri-methylamine and tetra-methyl-ammonium, the whole of the chloride being thus converted.

Drechsel has succeeded in forming trimethyl-phosphine by heating together phosphonium iodide and carbon disulphide.

Engel has discovered some new reactions of glycocoll. It gives with ferric chloride an intense red color, and it develops a blue coloration when treated with a drop of phenol and sodium hypochlorite is added. The author can not get the blood-red coloration as observed by Horsford when glycocoll is boiled with a solution of potassium or barium hydrate; he hence supposes that Horsford's substance was not pure.

Baumann finds that Hallwachs's amido-dicyanic acid, by heating with sulphuric acid, is converted into biuret.

Engel has given evidence to show that taurin, generally considered to be isethionamide, is really an amic acid. In the first place, it forms salts, that with mercury having been analyzed; and, secondly, treated with cyanamide in excess, it yields a taurin-creatin.

Ponomareff, by the action of persulphocyanogen upon ammonia at 100°, obtained two products: one the thiomelanuric acid of Jamieson; the other a new body, which he calls thiammelin.

Hesse has given some simple methods of testing the cinchona alkaloids. He distinguishes quinidine from quinine, cinchonine, and cinchonidine by means of the behavior of water and ammonia with their iodhydrates. If to half a gramme of salt to be tested ten cubic centimeters of water be added, the whole warmed to 60° C., and half a gramme of potassium iodide be added, allowed to cool, and after the lapse of an hour filtered; then, if the quinidine be pure, no turbidity results on adding a drop of ammonia. A precipitate under these circumstances proves the presence of one of the other three alkaloids.

Howard has made an examination of the bark known as *Cinchona pelleterana*, in order to prove finally the existence or non-existence of the alkaloid aricine. His results confirm those of other observers, and point strongly to the existence of aricine as a distinct alkaloid.

Gorup Besanez notices the introduction into commerce from Manilla of a brown extract from *Echitas scolaris*, a tree belonging to the Apocynaceæ, as a febrifuge, under the name Ditain. He succeeded in extracting from it a crystallized non-volatile alkaloid. It is offered as a substitute for quinine.

Jobst and Hesse subsequently made an exhaustive investigation of dita bark, which came from the Philippine Islands. From it had been obtained by Gruppe the substance called ditain, which the authors believe to be of uncertain composition. They confined their examination to the bark itself, and obtained from it several bodies, to which they give the names ditamin, echikautschin, echicerin, echitin, echitein, and echiretin.

PHYSIOLOGICAL CHEMISTRY.

In Physiological Chemistry, Boehm has continued his experiments on the respiration of water plants. He finds that much less oxygen is consumed by them than by land plants, and correspondingly much less carbonic acid is evolved. Indeed, he thinks the relation between the two much the same as between gill-breathing and warm-blooded animals. When dead, these water plants undergo a fermentation, attended with the absorption of hydrogen. He has more recently studied the decomposition which marsh and water plants undergo under water. He finds that the butyric fermentation takes place, that carbon dioxide and marsh gases are evolved, and that the liquid becomes alkaline from the evolution of ammonia. A partial conversion into peat is finally observed.

Bender has analyzed the gas given off by apples when they are exposed to the air in a finely divided state. The experiment was made on gas prepared by heating the apples, cut in small pieces, in a flask filled with water from which the air had been previously expelled by boiling. At 60° gas bubbles appeared, and became rapid at 100°. Four apples yielded about 100 cubic centimeters of gas, composed in the first experiment of 40.20 per cent. of carbonic acid, 0.43 per cent. of oxygen, and 59.37 per cent. of nitrogen. In subsequent trials more care was taken to exclude the air, and the gas collected consisted of 31.07 per cent. of carbonic acid and 68.93 per cent. of nitrogen. The author thinks the carbonic acid the result of a continuous fermentation going on within the mass.

Boettger states that a dilute solution of ammonia, or a moderately concentrated one of potassium or sodium hydrate, facilitates remarkably the germination of seeds, even of coffee, which usually germinates with difficulty. Grains of coffee moistened with such a solution of potash show, even after the lapse of a few hours, a snow-white plumule one to two millimeters long.

Pierce has studied the physiological action of cotarnine as contrasted with that of hydrocotarnine. While half a gramme of the former could be subcutaneously injected into rabbits and kittens without effect, a similar dose of the latter produced rapid and well-marked tremors, passing into severe epileptiform convulsions, sometimes proving fatal.

Gerber has described a new and more accurate method for the analysis of milk, by which he obtains some very satisfactory results.

Gautier, by dissolving fresh blood-fibrin in a solution of sodium chloride and dialyzing, has obtained a solution which coagulates by heat, and exhibits nearly all the properties of albumin.

Schutzenberger has continued his researches upon albumin, and gives now the general conclusion that albumin and its congeners are combinations of urea or of oxamide with either saturated or non-saturated amic acids belonging to well-known series.

Boussingault has made analyses of gluten biscuit, with comparative analyses of other similar articles of food, with a view of showing its real value when used as food in cases of glycosuria. From his table it appears, for example, that 73 pounds of baker's bread introduces as much starch into the system as 100 pounds of the gluten biscuit, while the latter affords eight times as much albuminates.

Maly has published a paper on the chemical composition and the physiological importance of the peptones.

Epstein and Müller have sought to throw some light on the beneficial effect of phenol on glycosuria by ascertaining whether phenol prevented at all the action of the liver ferment on the glycogen. Their results were negative. Acids suspend the action of this ferment, while alkalies simply lessen it.

Thudichum has published an extended memoir on bilirubin and its compounds, in which he maintains that the transformation claimed by Maly of this substance into urochrome has not yet been effected.

Scolosuboff has determined that the principal localization of arsenic in animals poisoned with this substance is in the nerve tissue. Hence, in all cases of acute poisoning, the brain should especially be examined, since, when the case is a very rapid one, even the liver may not contain a detectable amount of this poison.

TECHNICAL CHEMISTRY.

In Technical Chemistry, Stierlien has given a method for the detection of the artificial coloring matters used in red wines, together with the results of his examination by it. In these wines he finds logwood, Brazil-wood, red poppy, mallow, blueberry, cherry, elderberry, cochineal, litmus, aniline red, and red beet.

Fordos has published an additional paper on the action of liquids, used for food or medicinally, upon the so-called tin lining of utensils which contain lead. He shows that the deleterious results of the use of such vessels are far more general than is supposed.

Müntz and Ramspacher propose to determine tannin in its solutions by filtering these, under pressure if necessary, through a piece of fresh hide. This combines with the tannin, and the filtrate is entirely free from this substance. A section of the skin afterward shows a line in the middle, above which the skin has thus been converted into leather.

Vogel has continued his researches on the effect of coloring matters on the sensitiveness of collodion to the various rays of the spectrum, and now concludes that the action of the coloring matter may be quite different, according to the nature of the silver salt employed. Naphthalin red, used with silver bromide and silver chloride, gives to both an increased sensitiveness to yellow rays; while fuchsin acts very differently, being with silver bromide in complete accordance with its absorption spectrum—which is similar to that of naphthalin red—but giving to silver chloride but little increased delicacy for yellow rays, but much for the violet ones. The same fact he has observed to be true of certain colorless bodies; morphine, for example, increasing the delicacy of silver iodobromide not only for the blue and violet, but also for the green, while silver bromide is completely unaffected by it. Hence, to produce the effect he at first described, three things are necessary: first, the coloring matter must optically absorb the identical color which the collodion is to be made sensitive to; second, it must unite with any free bromine or iodine; and, third, it must not decompose silver nitrate, since in that case it would injure the preparation of the plates. The so-called night-blue, for example, possesses the first and third conditions, but fails on the second. It has no action, therefore, on the sensitiveness of silver salts to light of different colors.

Carey Lea has published a paper upon the influence exerted by color in changing the sensitiveness of substances to light. He finds, for example, that corallin increases the sensitiveness of silver bromide to red rays, only moderately increases it for yellow rays, and does not increase it at all for green rays, contrary to the view of Vogel. He concludes that there is no relation whatever between the color of substances and the color of the ray to whose influence they modify the sensitiveness of silver bromide.

Vogel, however, maintains that while the chloride, bromide, and iodide of silver are sensitive to rays of both high and low refrangibility, this sensitiveness also depends on the bodies which may be mixed with them, those colored bodies which absorb certain colors (and which promote photographic reduction) increasing the sensibility of the silver salt for the absorbed rays. Moreover, certain colorless bodies which promote photographic reduction, and certain others which influence the index of refraction, also modify the color-sensibility.

MINERALOGY.

The mineralogists in this country and abroad have been far from inactive during the past year, as, in fact, is well shown in the long list of new minerals which is appended. Their investigations have covered a considerable part of the known mineral species, and have resulted in adding much to what has already been published about them.

One of the most important of these memoirs is that by Des Cloizeaux on the optical properties of the feldspar family. He is a profound authority on such subjects, so that these investigations, including a ready means for distinguishing the different feldspar species, become of very great value. The same author has given a crystallographic and optical description of the rare species durangite, which was named some years since by Professor Brush. Another important French contribution to the science is a memoir by Daubrée on the recent formation of a number of minerals in the thermal waters at Bourbonne-les-Bains; these include tetrahedrite, bornite, anglesite, etc. These observations are important as bearing upon the paragenesis of minerals in general.

The number of doubtful minerals has been diminished by the chemical and microscopical studies of Mr. G. W. Hawes, who has shown that neither *chlorastrolite* nor *zonochlorite* deserve places as distinct species. A similar service has been performed by Professor Klein, who by a series of crystallographic investigations has shown that the supposed *wiserine* of Kenngott is nothing but a peculiar form of *octahedrite*. Mr. Hawes has also put the very doubtful mineral of Liebe, *diabantachronnyn*, on a proper footing. The mineral in question is important as occurring frequently in some igneous rocks, and is now called *diabantite*. Professor Cooke has continued his investigations of the vermiculites, alluded to in the last volume of the *Annual Record*, and has described two new varieties, which throw light on the composition of the group.

Other important memoirs have been contributed by Maskelyne in England, Vom Rath, Websky, Von Zepharovich, and others, in Germany; these are to be found in the various journals, but it would be out of place to refer to them here.

A variety of new mineral localities have been opened in this country, which in future may be expected to produce fine specimens. Perhaps the most remarkable discovery is that of the very rare species *samarskite*, in large quantities in North Carolina. Hitherto it has been known only in small imbedded fragments, but now it has been found in large masses: one obtained by Mr. J. Willcox weighed about twenty pounds, and a second thirteen pounds. Another interesting locality is that of Pike's Peak, Colorado, which has recently afforded crystals of smoky quartz, rivaling those of the Alps, and also very beautiful crystals of a bluish-green feldspar (Amazon stone). The chondrodite locality, at Brewster, N. Y., has produced some fine specimens, and the crystals have been shown to be quite unique in the complexity of their forms.

One of the most valuable additions to the list of mineralogical books is the volume by Dr. Genth, on the mineralogy of the State of Pennsylvania. It includes descriptions of the various mineral localities in the state, with the results of extensive chemical work by the author. Another important publication is the continuation of the mineralogy of Russia by Kokscharow, containing the results of much crystallographic research. Still another work is that completing the series of Hessenberg's "Mineralogical Notices," published after the death of the author, whose loss is a great one for the science.

The following is a list of the new minerals recently introduced into the science; those from American localities are mentioned in a little more detail than the others:

Byerite is a new variety of bituminous coal, described by Mallet as occurring in the Middle Park, Colorado. It is remarkable in yielding a large amount of gas and tarry oil.

Chalcophanite is a new mineral from that most interesting and prolific locality, the zinc mines at Stirling, N. J. It occurs in small tabular crystals and crystalline masses, resembling specular iron at first sight. In composition it is a hydrate of zinc and manganese, related to psilomelane. It takes on a brass color on being heated, whence its name. It was described by Dr. G. E. Moore in the July number of the *American Chemist.*

Chlorotile.—A hydrous arseniate of copper, of a pale green color. Found by Frenzel at Schneeberg, Saxony.

Clarite.—A supposed new sulphide of antimony and copper, resembling enargite, from a mine in the Black Forest. Described by Sandberger.

Cossaite.—A mineral near paragonite, from the mines of Borgofranco, Italy. Described by Gastaldi.

Frenzelite.—A selenide of bismuth from Guanajuato, Mexico. It occurs massive, with distinct cleavage; also in minute needle-like crystals. It has a bluish-black color, and metallic lustre. It was first mentioned by Castillo, but since then more completely described by Frenzel.

Garnierite; Nouméite.—Liversidge, in the Journal of the Chemical Society, has given these names to two hydrous silicates of nickel and magnesia found in serpentine at Noumea, in New Caledonia. Both minerals are distinguished by their apple-green color; they are supposed to differ somewhat in composition, as also in physical characters.

Hydrofranklinite.—Another new mineral from the zinc mines in New Jersey. It appears to be, like chalcophanite, a hydrous oxide of zinc and manganese, but occurs in regular octahedrons. It has been announced by Professor Roepper, though not yet fully described.

Hydrocuprite.—Hydrous oxide of copper; occurring in orange-yellow coatings at Cornwall, Pa. Described by Dr. Genth in the "Mineralogy of Pennsylvania" already alluded to.

Indianaite.—A new porcelain clay from Lawrence County, Indiana. Described by Professor Cox at the meeting of the American Association at Detroit, in August.

Koppite.—A mineral closely related to pyrochlore; from the Kaiserstuhlgebirge, Baden.

Melanosiderite.—This is a basic silicate of iron, related to limonite. It is of a black color, vitreous lustre, and with a conchoidal fracture. It is found at West Chester, Pa., and was described by Professor J. G. Cooke.

Rauite.—A hydrous silicate, perhaps identical with thomsonite. It is from the island of Lamö, near Norway.

Rivotite contains antimonic acid and carbonate of copper, amorphous with yellow color. Described by Ducloux.

Siegburgite.—A new hydrocarbon, containing eighty-five per cent. of carbon. Found at Siegburg, near Bonn.

Wapplerite.—An arseniate of lime, containing water. It crystallizes in the triclinic system; and is allied to pharmacolite. Found by Frenzel at Joachimsthal.

In addition to the above, Scacchi, in a recent memoir on the eruption of Vesuvius in 1872, has described the following new minerals found by him as products of sublimation: Atelite, chlorocalcite, cryptohalite, chloromagnesite, chlorallumīnite, cupromagnesite, dolerophanite, erythrosiderite, chlorothionite, hydrofluorite, hydrocyanite, proidonite, pseudocotunnite. For their characters, as far as described, reference must be made to the original research.

GEOLOGY.

Much attention has of late been turned to the study of the crystalline rocks in the southern part of the great Appalachian chain, and many important observations have been made. According to Eugene Smith, the state geologist of Alabama, we find to the southeast of the undoubted paleozoic rocks in that state a belt of crystalline limestones, which are overlaid, in apparent conformability, by a series of strata estimated at 15,000 to 20,000 feet, the whole dipping at high angles to the southeast. These consist of greenish-gray hydro-mica schists, the so-called talcose slates or nacreous argillites, inclosing layers of quartz in their upper part, and succeeded by great beds of quartzite, laminated, schistose, and conglomerate, with chloritic and talcose schists and roofing-slates. These, regarded by Professor Smith as the equivalents of the Ocoee group of East Tennessee, are by him considered probably of pre-Cambrian or Eozoic age, and referred to the Huronian.

They are succeeded to the southeast by gneisses, hornblendic rocks, and coarse mica-slates with granitic veins, considered by Smith as belonging to the White Mountain series, which alternate with belts of Huronian to the eastward. In one locality the schists are associated with a hypersthenic labradorite rock supposed to be Norian. The unaltered paleozoic strata along the western border are described as dipping toward and apparently passing beneath the adjacent crystalline rocks, a phenomenon well known throughout the Appalachian valley, and due to dislocations in the strata.

The extension of this western belt of crystalline rocks into North Carolina is also by Professor Kerr referred to the Huronian, in which he includes all of the rocks in that state described by Emmons as Taconic. There are good reasons for regarding the lower portions of his Taconic system as Eozoic. In his recent geological map of North Carolina, Professor Kerr groups the crystalline rocks of the state under the three heads of Granites, Huronian, and Laurentian. Some portions of the latter area examined by the writer have, however, been by him referred to the Montalban or White Mountain series. Bradley has lately endeavored to show that the whole of these crystalline strata in North Carolina and East Tennessee are the lower paleozoic rocks, including the Cincinnati group, in an altered condition, thus resuscitating the old views of Rogers, combated more than thirty years ago by Emmons, and since by Hunt and others. Bradley offers in support of this view only conjectures based on supposed lithological parallelisms, which, when we consider the great mineralogical and physical differences, and the entire absence of organic remains in the rocks in question, have very little weight. The alteration and the uplifting of these crystalline strata of the Blue Ridge are by Bradley supposed to be post-Carboniferous, which does not agree with the observations of Fontaine and others, whose observations show these crystalline rocks to have formed the southeastern barrier of the paleozoic sea.

Fontaine describes the Blue Ridge in Virginia as having an axis of coarse granitic and syenitic gneiss, referred by him to the Laurentian series, which is seen near Lynchburg and in the Peaks of Otter, where these gneisses are penetrated by intrusive syenites, and is developed in greater force as we proceed southwestward. Resting unconformably on both sides of this ancient series is a group of schistose rocks which to the northward conceal the Laurentian. This series, which consists in large part of argillites and micaceous and chloritic schists, with epidotic, hornblendic, feldspathic, and quartzose admixtures, he compares to the Green Mountain series, and suggests that they may be Huronian. To the east of the Laurentian, and apparently occupying a synclinal, in the schists just mentioned, is a series of folded limestones, with micaceous schists, quartzites, and roofing-slates, closely resembling the Taconic rocks of Berkshire County, Massachusetts, and apparently the prolongation of the Taconic belt indicated by Emmons to the east of the Blue Ridge in North Carolina, and described by him as extending northward through Virginia into Maryland. This, Fontaine thinks, may be altered Silurian, but he speaks with doubt. These crystalline schists to the east of the Laurentian axis are designated as the middle belt, and beyond is still an eastern belt of well-defined granitoid gneisses, overlaid by mica-schists with gneisses, often hornblendic, disposed in broad anticlinals and synclinals, with dips of from 40° to 50° to the east and west. These are said to have the characters of the White Mountain series.

Along the western flank of the Blue Ridge, resting unconformably upon the crystalline strata, is a series of sandstones, shales, and conglomerates, rapidly augmenting in thickness to the southwest, and attaining in the middle of the state over 2000 feet, though not over 1000 feet at Harper's Ferry. These strata, which underlie the so-called Calciferous formation, are destitute of all traces of organic remains except Scolithus. They contain in the conglomerates pebbles of the crystalline argillites (Huronian), as well as feldspar and kaolin from the old Laurentian gneisses, showing, as Fontaine remarks, that these crystalline rocks formed the border of the ancient sea. The strata to the northwest have been greatly folded and faulted, so that these beds in many parts plunge beneath the crystalline Huronian schists, the two dipping at high angles to the southeast, though unconformable. The limestones, which, near Harper's Ferry, include a bed of limonite, also dip southeast at a very high angle. In some parts of the valley the foldings and overturned dips are such that the Hudson River slates, according to Fontaine, rest upon the Devonian, and even upon the Lower Carboniferous of the North Mountain. Similar observations were long since, in this region, made by Rogers, Emmons, and Lesley. In other parts of the valley, however, this state of things does not exist, and the more ancient slates and conglomerates repose with a high northwest dip on the flank of the Blue Ridge.

An important deduction by Fontaine, from his examinations of the rocks in Virginia, is that there is no ground for the conclusions of H. D. Rogers that the folds of the Appalachian system extend to the Atlantic, and are more compressed next the ocean, while widening out to the west. In fact, the White Mountain rocks of the eastern are less disturbed than the Huronian of the middle belt. "Such a connection does exist between the flexures of the Silurian, Devonian, and Carboniferous areas, but the Blue Ridge is the initial point on the east."

The writer may remark in this connection that these strata from Harper's Ferry, for a few miles east along the Baltimore and Ohio Railway, offer all the types of the Huronian or Green Mountain series, while the gneisses and mica-schists nearer Baltimore present the characters of the Montalban or White Mountain series. Pebbles of these latter rocks, derived from the Blue Ridge, abound in the conglomerates which with sandstones and shales make up the Iron Mountain on the southeast side of the great Appalachian valley in Grayson County, Virginia.

Dawson has lately discussed anew the facts with regard to some of the Eozoic rocks of Canada, recalling his old observation that the post-Laurentian which in Madoc, Ontario, contain eozoon, present also forms like Scolithus. He has again studied the conditions under which *Eozoon Canadense* occurs in its original locality on the Ottawa, in the province of Quebec. The eozoal limestone forms a thick belt in the gneiss, but the eozoon is abundant only in a bed of four feet, which contains bands and concretions of serpentine, and is traversed by veins of chrysotile. Along with these are laminated masses of serpentine and calcite which are entire specimens of eozoon. Fragmental portions retaining the structure of eozoon are also dispersed in layers through the adjacent beds of limestone, embedded in which are moreover casts in serpentine of small chambers, single or in groups, having the form and mode of aggregation of globigerina, but with the proper wall of eozoon. These he has provisionally named *Archæospherina.* The eozoon is generally preserved by infiltration with serpentine; but some specimens in dolomitic limestone have their canals filled with transparent crystalline dolomite, while the skeleton is still pure carbonate of lime.

In Missouri the published results of the geological survey by Pumpelly and Schmidt have added to our knowledge of the ancient crystalline rocks which rise through the paleozoic strata in the southeastern part of the state, and evidently formed islands in the paleozoic sea. These eozoic rocks consist in great part of stratified petrosilex, often jasper-like, and frequently becoming a feldspar-porphyry; with it are associated argillites and talcose slates, and more rarely layers of quartzite and of crystalline limestone. The rocks have been compared by Hunt with the similar petrosilex-porphyries of Lake Superior and of the eastern coast of New England, where they form a part of the great Huronian series. They are the iron-bearing rocks of Southeastern Missouri, in which the red oxyd is found either in beds, as at Pilot Knob, or, according to Dr. Schmidt, in great veins, as in the Iron Mountain. The granites of the region apparently break through these ancient crystalline strata. Details are given with regard to the numerous deposits of iron, lead, and copper ores in the paleozoic strata, affording important data for a theory of ore-deposits. The lead ores of this region are not confined, as was formerly supposed, to the strata below the Trenton, but are found in the sub-Carboniferous limestones and even in the coal-measures. The similar deposits of this ore in the valley of the Upper Mississippi, as is well known, are in a formation just above the Trenton, and the question is now raised whether throughout this wide region the deposition of this metal went on at intervals throughout the whole of the paleozoic period, or whether it was, as suggested by Dr. Schmidt, introduced into these various formations at a later date.

In the lower Carboniferous a deposit of chert, which in some localities is over one hundred feet in thickness, constitutes one of the principal lead-bearing rocks in the region. The coal in the northeast part of the state is remarkable for occurring in deposits of very limited area, but of great thickness, sometimes as much as twenty-five feet, with very little of the usually accompanying strata. These accumulations are supposed to have been formed in small hollows in the surface of the lower Carboniferous limestone. An artesian well lately sunk in St. Louis, Mo., has a depth of 3843 feet. Beneath forty feet of surface deposits lie the Carboniferous rocks, the base of which was reached at 883 feet. These are directly followed by the limestones and shales of the Trenton or Cincinnati group, measuring 421 feet, beneath which were not less than 2489 feet of magnesian limestones with sandstones and some magnesian slates—the whole resting on red granitic rock, which was penetrated forty feet. Salt water was first met with in the Trenton limestone at 1220 feet, and the lower strata yielded brines which contained seven and eight per cent. of saline matter. The temperature in these lower depths is from 105° to 107° Fahr.

The paleozoic coal-formation of the Appalachian is for convenience divided into a lower and an upper series; the base of the latter being the great Pittsburgh seam, which is a sheet of coal known over a length of 225 miles and a breadth of 100. Many questions have arisen as to the equivalency of the seams in the lower coal-measures in different parts of the coal-field. Counting from the base of the formation, which in Ohio and Western Pennsylvania is found at a vertical distance of from 500 to 900 feet beneath the Pittsburgh seam, Andrews and Fontaine, from their discoveries in West Virginia, have arrived at the very important conclusion that the base of the coal-measures of the lower series on the Kanawha is not less than 3100 feet below the Pittsburgh seam. From this it would follow that in this region there was, at the beginning of the coal period, a vast basin or depression between highlands of older rocks to the southeast and the great plateau of the Waverley sandstones rising toward the ridge of the Cincinnati uplift to the northwest. Nor was it until this great valley had been filled up with 2000 feet or more of coal-measures, including the important coal-beds of West Virginia, that the general subsidence allowed the coal-formation to be spread over the northwest plateau to a depth of a few hundred feet, which there intervene between the unconformable floor and the Pittsburgh seam. Beneath this lower series in West Virginia is a still lower group measuring 1200 feet in thickness with coal seams, and having at the summit a heavy conglomerate sand-rock. These correspond to the sub-conglomerate coals studied by Lesley in Southwestern Virginia, and to the small coal-beds lately found by the Second Geological Survey of Pennsylvania in the division No. X., or so-called vespertine strata, which lie at the top of the Catskill Mountain group of the New York survey. This series has been studied anew by Professor Hall and Mr. Sherwood, confirming the old view of its geological distinctness, which had been disputed. It has been traced in New York as far north as Schoharie County, and carefully mapped. Six distinct and nearly parallel ridges, synclinal in form, with eroded anticlinals, have been observed, some of them carrying in their shallow folds the vespertine and umbral beds, which farther southward lie beneath the anthracites of Pennsylvania.

Andrews has inquired into the question of the supposed equivalency of the coal seams of the anthracite region with those of Ohio, Western Pennsylvania, and West Virginia, which he regards as still undetermined. He concludes, moreover, from the various conglomerates to be found at different horizons in the coal-measures, that the so-called basal conglomerate in Pennsylvania can no longer be regarded as marking a geological horizon, but has only a lithological significance.

The question whether the coal-formation of the Rocky Mountains is to be classed with the cretaceous or the tertiary has been much discussed during the past year, but according to the late results of Major Powell the solution is very simple. The workable coals, or lignites, as they are often called, extend in this region throughout the whole of the cretaceous formation, which has a mean thickness of 6500 feet, and through the inferior half of the tertiary, including the Upper and Lower Green River beds (1500 feet), and the Bitter Creek beds (3500 feet), making in all more than 10,000 feet of coal-bearing strata, which are overlaid unconformably by newer tertiary rocks. There is, moreover, a want of conformity in this series between the Bitter Creek beds and the underlying Rock Springs group, which is cretaceous. The strata from which Lesquereux obtained tertiary plants are above this stratigraphical break, by which they are separated from adjacent beds holding cretaceous mollusks. Thus a more careful stratigraphical study has served to harmonize the apparently conflicting evidence of paleontology. The remains of the Dinosaurs of Black Butte are, however, accompanied by tertiary mollusks and plants.—*Record*, 1874, p. lxx.

Beneath the mesozoic rocks, which include jurassic and triassic strata, are immense thicknesses of paleozoic rocks, including Carboniferous, Devonian, Silurian, and Cambrian, the whole series, from the top of the tertiary to the paleozoic base, having, according to the estimate of Major Powell, a thickness of about 60,000 feet. Beneath all these is a series of crystalline schists, of which about 5000 feet have been measured. The crystalline strata of this region, according to this observer, are every where of great and unknown age.—*Record*, 1873, p. xlvii.

Professor Marsh has discussed the cenozoic formations of the West, and pointed out the existence of several great basins corresponding to fresh-water lakes of former periods, which are now filled with deposits whose organic remains enable us to assign them to different divisions of tertiary time. The great Green River basin, lying between the Rocky Mountains and the Wahsatch range, has the Uintah Mountains on the south and the Wind River Mountains on the north. Its nearly horizontal strata, with a total thickness of 6000 feet, rest unconformably upon the lignitic or cretaceous coal-bearing strata (often highly inclined), and have yielded the remains of not less than 150 species of eocene age. This region remained dry land during the miocene time, perhaps much longer, but was afterward submerged, and has suffered great erosion. A still larger lake existed in eocene time to the south of the Uintah Mountains, and at a much lower level than the last. South of the Black Hills is a great miocene area, the White River Lake basin, extending from the Rocky Mountains to the 99th meridian, and from the 40th to the 44th parallel. Its strata, which consist of fine materials, have a thickness of about 300 feet, and rest like the preceding on the cretaceous. This area constitutes the well-known "bad lands" of that region. Another miocene basin exists in Central Oregon, in great part concealed under more recent basaltic rocks. These strata, which are more or less inclined, and have a thickness of not less than 5000 feet, include in their lower portions a fauna regarded as miocene, but more ancient than that of the White River basin, which is, however, represented in the upper portions of the Oregon basin. Lying in part over the first-named miocene basin was a great pliocene lake, having nearly the same limits as it to the north and west, but with an area about five times as large, and extending eastward and also southward nearly to the Gulf of Mexico. The deposits of this pliocene area, known as the Niobrara basin, attain a thickness of 1500 feet, and contain organic remains which indicate a warm temperate climate, while that of the eocene was tropical, and that of the miocene intermediate between the two. The great erosion which all this region has suffered is well set forth by Dr. Hayden, when he states that from 10,000 to 15,000 feet of strata, from the paleozoic upward, have been removed, leaving only "what may be called remnants behind, occupying restricted areas. The hard and compact limestones of the Silurian and Carboniferous ages are found to a greater or less extent all over the Northwest. They yield much less readily to erosion than the more modern rocks, and are consequently to be found on the summits of the largest mountains 10,000 and 12,000 feet above the sea."

Dr. Newberry, in his lately published volume of the geology of Ohio, has given a full and careful discussion of all the facts known with regard to the superficial geology of the state and the adjacent regions, and has connected them with the hypothesis of land-glaciation. Professor Dana has given his views with regard to the former existence and extent of a great New England glacier.

Mr. George M. Dawson has studied the physical geography and superficial geology of Central Canada between the Rocky Mountains and the great Laurentian axis, which from Lake Superior stretches northwestward to the Arctic Sea. Rising from the lowest plateau of the Red River and Lake Winnipeg, 800 feet above the sea, we have to the west the Great Plains of the middle plateau, 1600 feet above the sea, and the third or western plateau rising to from 2500 to 4000 feet. Over the latter two are abundant deposits of unstratified drift, which in the middle plateau is almost wholly from the crystalline rocks of the eastern range or Laurentian axis and the limestones adjacent, while on the higher western plateau, though boulders from the latter region still abound, more than one half the drift is from the Rocky Mountains. These themselves afford abundant evidence of glaciers. The author conceives that sub-aerial denudation had already given to the region nearly its present surface before the glacial period. He concludes that the phenomena of the drift in these regions do not require to account for them a polar ice-cap, but are to be explained by the action of local glaciers from the Laurentian axis drifted westward across the submerged prairies toward the Rocky Mountains.

In England the nature and causes of the drift formation have been much discussed. The intercalation of stratified deposits in the unstratified drift, and the presence in both of marine remains, apparently indicate for a part, if not the whole, a submarine origin. In order to conciliate these facts with the hypothesis of a great ice-sheet, Mr. Goodchild has attempted to show that none of the phenomena prove the former agency of the sea, but that all these deposits were formed under land-ice, and in part by the agency of sub-glacial streams, the ice-sheet having excavated from their ocean-bed and pushed up on the land the marine deposits in its onward march. There is, however, a strong reaction from this hypothesis in England [*Record*, 1874, p. lxxiv.], and several of Goodchild's colleagues in the Geological Survey of the United Kingdom have opposed him in recent papers, notably Hardman, Dakins, and Ward. The latter observes, "The difficulties involved in the theories of Croll, Belt, Goodchild, and others of the same extreme school, certainly press upon me—and I think I may say also upon others of my colleagues—increasingly as the country becomes more and more familiar in its features." He suggests, from the observations of late arctic voyages, that prevailing winds acting upon the surface-ice, rather than currents, are to be taken into account in considering the distribution of drift boulders, and quotes the language of Sedgwick in 1842, who, referring to the transport of granite blocks from the hills of Cumberland to the shores of the German Ocean, says, "No one, I trust, will be so bold as to affirm that an uninterrupted glacier could ever have extended from Shap Fells to the coast of Holderness, and borne along the blocks of granite through the whole distance without any help from the floating power of water. The supposition involves difficulties tenfold greater than are implied in the phenomena it pretends to account for. The glaciers descending from the Alps have an enormous transporting power, but there is no such transporting power in a great sheet of ice expanding over a country without mountains and nearly at a dead level."

Campbell, the author of "Frost and Fire," who has devoted, he tells us, thirty-three years to the study of glacial phenomena in both continents, and long held the hypothesis of Agassiz, believing that all Northern Europe had been buried beneath an ice-cap, has been led by further studies in Russia and in North America to reject this view, and declares that from the Caucasus to the Rocky Mountains he sees no evidence of an ice-cap. He adds concisely that "the glacial traces in North America seem to indicate the transfer of oceans with their systems of circulation from one part of the world to another by the elevation and depression of the land."

Kinahan, of the Geological Survey of Ireland, has made known in the western parts of Galway and Mayo a series of crystalline rocks which may be compared with those of our Appalachian belt. They consist of bedded granites and gneissic and hornblendic strata, quartzites, limestones, micaceous and talcose schists, serpentines, steatites, etc., and are divided by the author into three groups, the united thickness of which is estimated at over 10,000 feet. They are wholly without fossils, and are penetrated by granitic and other intrusive rocks. Being overlaid by fossiliferous strata of Silurian (Llandovery) age, it is conjectured by Kinahan that they may be altered Cambro-Silurian rocks. The similar crystalline schists of Donegal, as long since pointed out by the writer, are partly Huronian and partly Montalban. The hasty generalizations and misinterpretations through which in so many regions geologists have incorrectly referred crystalline strata like these to paleozoic or more recent times [*Record*, 1872, p. xxxvii.], have recently received a further illustration in Carinthia, where, on the authority of Suess, the mica-schists and the granites of Casanna and the Gailthal have been described as Carboniferous, and supposed to be even more recent than certain strata undoubtedly of this age. Stache has shown that, besides the Carboniferous beds, important masses of fossiliferous Silurian and Cambrian strata are present, and that the crystalline schists of the region really occupy a position unconformably beneath the old paleozoic strata.

The evidence accumulates that the whole Cambrian series in Wales, as originally defined by Sedgwick [*Record*, 1872, p. xxxvi.], extending upward to the unconformably overlying May Hill sandstone (the equivalent of the Oneida of the New York system), is a single physical series. The stratigraphical breaks supposed by Ramsay to exist in Wales above and below the Tremadoc rocks are not recognized by Hicks in his recent study of the ancient rocks at St. David's. The two most important paleontological breaks are at the top of the Menevian and of the Tremadoc. The Silurian and Cambrian nomenclature is again much discussed in England, and the fact that the Silurian of Murchison has not and never has had any base-line is insisted upon. Some, with Hughes, follow Sedgwick in confining the Silurian to the strata above the May Hill sandstone, and give to the rocks from this horizon to the top of the Tremadoc the name of Upper Cambrian, originally applied by Sedgwick; while a greater number restrict the name of Cambrian to the strata below the last-named horizon, and give the name of Cambro-Silurian, or that of Lower Silurian, to the Upper Cambrian. Dewalque has investigated the ancient rocks of the Ardennes, in Belgium, and shown that the whole series of the Cambrian from the Harlech to the Tremadoc inclusive, is probably represented in that region.

The researches of J. Arthur Phillips on the metalliferous rocks of Cornwall cover a great variety of important points. He shows, from a large number of chemical analyses and microscopic studies, that the so-called killas are more or less crystalline schists, often containing crystallized magnetite, quartz, chlorite, and hornblende; and points out that, though of very varying composition, they all differ so widely from granite that no reconstruction or alteration of them could ever convert them into this rock, as speculators in geology have sometimes suggested. While some of the rocks of this region hitherto called greenstones are shown to be eruptive rocks, many of them are hornblendic schists. The intrusive granites and the elvans or quartziferous porphyries of the region are very similar in chemical and mineralogical composition. It is well known that Sorby, from a study of the vacuities in the minute cavities filled with liquid in the quartz of granites, endeavored, by noting the temperature at which these vacuities disappear from the expansion of the liquid, to calculate the temperature at which such rocks solidified—a result which, if established, would be of great importance to science. The studies of Phillips, however, confirm the previous ones of Zirkel, that the volume of the bubbles in the fluid-cavities has no constant relation to the liquid, so that we can not in this way attain any certain data. Both natural and artificial crystals contain fluid-cavities, with bubbles of various sizes, as well as cavities full of liquid, and others full of gas or vapor.

The vein-deposits of Cornwall, carrying copper and tin ôres with quartz, tourmaline, chlorite, calcite, fluorine, etc., have also been the subject of careful studies by Phillips, who sets forth very clearly the evidences of their aqueous origin; and concludes that the repeated widenings of the veins, of which there is abundant evidence, have been due to the expansive force of crystallization in the fissures, as long since pointed out by Hunt for the granitic veins of New England. The original opening appears to have been only a mere comminuted fracture of the rock in a given direction, between the surfaces of which mineral substances have crystallized from solutions, separating the fragments, and thus giving rise to a brecciated vein-stone. The temperature at which these materials have been deposited is supposed to have been often very moderate. From the mode in which quartz crystals are sometimes bent, and also from the fact that in a case where the fissure in a broken mass of crystalline quartz in a Cornish vein has been filled up with tourmaline, crystals of this mineral having penetrated the substance of the quartz, the author ventures the supposition that the quartz preserved for a time a soft and somewhat plastic condition. From the irregular contraction of such silicious masses after the solidification of the base it is suggested that the stone-filled cavities in the quartz of rocks like elvan may have originated. Phillips has further described in this connection the deposits from a solfatara in California, where a fissure, alternately filled with hot water and with vapors, has upon its walls crystalline quartz overlaid by chalcedony and by a gelatinous silica, which dries to a mass like chalcedony, and incloses a considerable portion of cinnabar. This quartz, which is supposed to be formed by the crystallization of the opaline silica, holds fluid-cavities with bubbles of varying size, as well as gas and vapor-cavities.

In this connection the observations of Daubrée are important. The old Roman baths of Bourbonne-les-Bains, in the department of the Haute Marne, in France, having been lately opened for repairs, there was found in the mud at the bottom of the well a very large number of medals, statuettes, and ornaments in bronze, silver, and gold, offerings in ancient times to the genius of the place. Beneath there was a layer of fragments of sandstone cemented together by crystalline minerals, which were also found incrusting some of the medals. Among these were the various sulphuretted ores of copper, chalcosine, covelline, phillipsite, chalcopyrite, and antimonial tetrahedrite—all distinctly crystallized; together with crystals of quartz supposed to be contemporaneous in origin with the sulphurets. A piece of lead was incrusted with cubical cleavable galena and anglesite, and in other parts of the deposit pyrite and crystals of calcite and chabazite were met with, as in the well-known similar cases of the thermal springs of Plombières and Luxeuil. The waters of Bourbonne, which rise through mesozoic strata, are strongly saline, and contain alkaline and earthy sulphates and chlorids. Their temperature is about 60° Centigrade; and it is clear that it is the action of these waters on the metals during many centuries which has generated these crystalline compounds, which present all the mineralogical characters of the same mineral species found in the veins of Cornwall and elsewhere.

J. D. Dana has described the curious associations of minerals at the Tilly Foster iron-mine in Putnam County, N. Y. The rocks are here hornblendic gneisses of Laurentian age, including beds of magnetite mingled with chondrodite, which is sometimes predominant. It is often associated with and penetrated by serpentine, and is accompanied by hornblende, enstatite, and chlorite. Veins and fissures cutting these ore-bearing strata are filled with a great variety of crystalline minerals, including those already named and many more. Among these is a mosaic of dolomite and serpentine, both in cubic forms, copied from some undetermined species. These imitated forms are at first described by Dana as pseudomorphous from alteration, but subsequently in the same paper as results of "substitution, and not of alteration;" the latter view being doubtless the correct one, though the precise mode of their formation is still obscure. Besides these, the vein-stones present a great variety of other interesting examples of substitution or replacement of contemporaneous crystallization and envelopment, which are often vaguely included under the name of pseudomorphs. The phenomena to be observed in vein-stones, where minerals have been successively formed in fissures which have been through long periods channels for the circulation of watery solutions of varying composition, alternately depositing crystals, incrusting them, dissolving them, and again depositing others, are exceedingly complicated; but it should be remembered that these various reactions are from the nature of things inapplicable to the solid masses of previously formed rocks.

The examinations of the deposits from deep-sea soundings have much geological interest. It appears from the observations made on board the *Challenger* that the deposit over great areas is a nearly pure calcareous ooze, chiefly made up of the shells of globigerina. Below 2000 fathoms, however, the calcareous matter diminishes in amount, and at 2600 fathoms disappears, a fine red clay, with silicious tests of diatoms and radiolarians, taking its place; while at still greater depths the proportion of clay diminishes, until at length the ooze consists chiefly of the remains of these silicious organisms, which are probably more abundant at great depths, while the foraminifera belong to shallower waters. The absence alike of these organisms and of their remains in deep waters is ascribed to the solvent action of the waters, augmented by pressure, and holding in solution carbonic acid, and the red clay is regarded as the insoluble residue from the globigerina ooze. It is described as a silicate of alumina and iron-oxyd, and is supposed to be related to the coloring matter of the red chalk of England, which is a silicate in which the iron often greatly predominates over the alumina, and, as Church has suggested, is probably a partially decomposed greensand, or glauconite, which in various parts of the sea-bottom is found, as in older formations, filling the cells of foraminifera, or appearing as casts of these from which the calcareous shells have been removed. The red soil which overlies the white coral-sand of Bermuda is in like manner a silicate containing more iron-oxyd than alumina, and is very unlike a true clay in composition. Whatever may have been the agencies by which the silica, iron, and alumina have been brought together to form the glauconite which after the death of the foraminifer replaces its sarcode, there is no apparent basis for the notion of the organic origin of clays, which has been suggested in this connection. The red clays from great depths contain more or less oxyd of manganese, which sometimes forms concretionary masses several inches in diameter, or coats with a mammillated layer pebbles and bits of pumice-stone in the red ooze. It has been suggested that this may have been accumulated through the agency of algæ, the ashes of some of which contain as much as four hundredths of manganese. The oceanic circulation, which, by carrying to the depths of the sea cold and aerated waters, makes possible these varied conditions of deposition, is, as Carpenter has shown, excluded from basins which, like the Mediterranean Sea, are cut off by submerged barriers from the flow of the polar waters; and hence the deposits at comparatively moderate depths are there almost destitute of organic remains. The bearing of all these facts upon the rock-formations of past ages is obvious.

GEOGRAPHY.

The progress in Geography during 1875 has not been marked by any very striking discovery, although a reasonable average in the way of the extension of our knowledge has been maintained.

The following may be considered as among the more important points in the history of the year:

Geodesy, Navigation, and Hydrography.—An International eodetical Congress was held on the 20th of September in

Paris, with General Haner, the delegate for Spain, as president. The German, Russian, and Austrian empires, together with Italy, Belgium, Roumania, Switzerland, and several German states, were represented. No delegate was present for Great Britain nor for the United States.

The much-vexed question of the difference in level between the Caspian Sea and Lake Aral has finally been settled by the Russian Commission, which ascertained that the mean height of the latter above the former is 242.77 feet, and 157 feet above the Black Sea. Heretofore the height of the Aral above the Black Sea was supposed not to exceed 27 feet.

The United States Hydrographic Office has published quite a number of important papers; among these may be mentioned the works of Lieutenant Gorringe on the Rio de la Plata, and that of Commander George Dewey on the coast of Lower California and Western Mexico, being the report of the recent cruise of the *Narragansett* in that region. Important information is given here in regard to various points on the coast, including the comparatively little-known Revillagigedo Islands to the south of Lower California, of which Socorro is the type. A report has been made by Lieutenant George F. Totten upon the northwest coast of Spain, and the coast of Portugal from Estaca to Cape Trafalgar. There has also been printed a report upon the soundings of the *Tuscarora* in the North Pacific Ocean.

The Ocean and its Depths.—The public attention is still directed toward the movements of the British surveying-ship *Challenger*, of which so frequent mention has been made in the *Annual Record.* It is probable, however, that her history will soon be closed, as she is expected to return to Great Britain in the spring of 1876. So far she has carried out fully the programme upon which she started several years ago, with the exception, perhaps, of the omission of a portion of the work assigned in the Aleutian Islands and on the northwest coast of America.

Taking up her history at the point to which we brought it in the last *Record*, she left Port Nicholson on the 7th of July, 1874, and proceeded under sail along the east coast of New Zealand, and thence to the Kermadec Islands. She reached Tongataboo on the 19th, from which she proceeded to the Fijis, where considerable time was spent in detailed explorations.

Leaving Kandaru on the 10th of August, the *Challenger* proceeded to Api, one of the New Hebrides, and thence to Raine Island, near the entrance to Torres Strait, a distance of about 1400 miles. After this she went to Arú—by way of Port Albany and Cape York—and then to the Ké group, and on to Amboyna, which was reached on the 4th of October.

From Amboyna the party proceeded to Ternate, and thence across the Molucca Passage into the Celebes Sea, and by way of the Sulu Sea to Manilla, where they arrived on the 4th of November. The vessel proceeded to Hong Kong, arriving November 16, from which point the collections made were forwarded to England.

Among the more important zoological results of this section of the cruise was the capture of a living pearly nautilus, which was kept for some time for the purpose of studying its movements and attitudes. After leaving the Ké Islands some fine specimens of undescribed species of pentacrinus were collected.

At Hong Kong Captain Nares, who had been in command of the vessel from the first, left, and proceeded to England to take charge of the preparations for the British Arctic Expedition; and the command of the vessel was assumed by Captain Frank T. Thomson, who left Hong Kong on the 6th of January, and reached Manilla on the 11th. Starting from Zebu on the 14th, soundings were taken, and on arrival there magnetic, tidal, and other observations made. From Zebu a run was made to the volcanic island of Camiguin, for the purpose of obtaining the depth of water and bottom temperature close under the volcano. Proceeding thence, after various stoppages, the vessel reached Humboldt Bay, on the coast of New Guinea, by the 23d of February. Here, however, the menacing attitude of the natives prevented landing and conducting further operations. Admiralty Island and Nares Harbor were reached on the evening of the 3d of March, and, the natives being friendly, a survey was commenced the next morning. Finding it impossible to reach Hogolu, in the Caroline Islands, or Guam, in the Ladrones, the steamer proceeded directly to Yokohama, from which place, arriving

April 11, the report has been forwarded. The deepest water obtained during the cruise was found on the 23d of March, in latitude 11° 24′ north, longitude 143° 16′ east, amounting to 4475 fathoms.

A sub-report, by Commander Tizard, has reference to the temperatures of the China, Sulu, Celebes, and Banda seas. It is remarked that the temperatures in the seas of the Indian Archipelago show that they have deep basins, cut off from the general oceanic circulation by ridges connecting the islands which surround them, and that after reaching a certain depth, representing the height of the ridge in question, the temperature remains the same to the bottom, and is of course much higher than would prevail at the same bottom-depth were it entirely open to the general circulation of the sea.

Since that date no information has been received in the United States in regard to the movements of the *Challenger*, beyond the telegraphic announcement of her arrival at Valparaiso on the 19th of November.

The Norwegian Legislature has, it is said, voted the sum of $24,000 for the purpose of prosecuting deep-sea investigations between Iceland, Spitzbergen, the Faroe Islands, and Jan-Mayen Island, the operations to be based upon the model of those of the *Challenger*.

The United States steamer the *Swatara*, which was detailed for service in the American Transit of Venus Expedition, and of which mention was made in the *Record* for 1874, left Hobart Town on the 17th of February, 1875, and reached Melbourne on the 19th. On the 1st of March the homeward voyage was entered upon. Tierra del Fuego was sighted on the 3d of April, and the equator crossed on the 6th of May, in longitude 38°. A short stop was made at Barbadoes on the 16th of May, just eleven weeks from Melbourne, for the purpose of securing a supply of water, and on the 20th she left for New York, where she arrived on the 31st of May, or one year after she had left that city in 1875. She brought back a large number of collections of natural history, gathered in Kerguelen Island, in Tasmania, in Australia, and at Chatham Island, by officers and members of the expedition, prominent among which were Dr. J. G. Kidder and Dr. Kershner, surgeons of the *Swatara*, Mr. J. B. Russell and Mr. Smith of the Coast Survey.

The publication of the report of the operations of the United States steamer *Tuscarora* has already been referred to; and Dr. Carpenter, in discussing her observations made in the deep seas between the United States and Japan, infers the general want of that sub-surface stratum of above 40° Fahr. which in the North Atlantic, with the same or yet higher parallels, has a thickness of at least 500 fathoms. The true cause of this peculiarity is that the North Pacific derives its deep stratum of glacial water, which nearly fills its basin, from the polar area of the opposite hemisphere, the inlet at Behring Strait being too narrow and too shallow to admit a flow of water of any appreciable importance. This northward flow of the water from the equator must have, as its complement, a movement of the superficial stratum from the northernmost limit of this flow *toward* the equator, and thence toward the southern pole. The glacial current when it reaches the North Pacific comes nearer the surface than it does in the Southern Ocean, even in the higher latitudes; and this, modifying still further the reflex surface flow toward the equator, appears to account for the well-known moderation of the climate of the Sandwich Islands, though they lie within the Tropic of Cancer.

The *Shearwater*, a British vessel, completed in 1875 a four years' course of surveying service, having been put in commission on the 20th of July, 1871, and returned to Sheerness on the 23d of July, 1875. She was originally commanded by Captain Nares, who, when transferred to the *Challenger*, was succeeded by Captain W. J. L. Wharton. While on her original duty in the Mediterranean she was employed for a time in prosecuting certain important physical investigations, under Dr. Carpenter, and after two years' service there she was sent to Zanzibar to survey that island and the opposite coast. In February, 1874, the vessel proceeded to the Cape of Good Hope, and left Cape Town July 14, with the Rodriguez transit party, remaining for some time at Rodriguez on specific service. She then transported the transit party to the Mauritius, and again proceeded to Zanzibar to continue her work there.

According to *Nature*, during the four years she has been in commission the vessel has surveyed in detail 790 miles of coast-line, and made many soundings over an area of 5900 square miles.

The Arctic Regions.—The principal event of the year in connection with the exploration of the arctic regions is the fitting out and departure of the great English expedition, of two vessels—the *Alert* and the *Discovery*—under command of Captain Nares, which left Portsmouth for the far North on the 29th of May. For many years past the authorities of Great Britain have been urged by her people to revive the traditional glories of the nation in the matter of arctic exploration; but it was not until 1874 that steps were actually taken in this direction. Once entered upon, however, no pains were spared to render the work a success. All the resources of science were called in to contribute suggestions and information, and no contingency, it is believed, has been left unprovided for that could be in any way anticipated.

The entire expedition is under the command of Captain Nares, of whom so frequent mention has been made in connection with his command of the *Challenger*, his flag-ship being the *Alert*. Her commanding officer is Commander Markham, who during the previous year had visited the arctic regions on board of a whaling steamer, for the purpose of obtaining a practical acquaintance with his new duties.

The *Discovery* is commanded by Captain Henry Stephenson, with the usual necessary staff and subordinate officers. While, of course, all the peculiar physical observations will be carefully attended to, as a part of the naval routine, both vessels have gentlemen on board competent to discharge the duties of ethnologists and naturalists. The two vessels were accompanied as far as Greenland by a third—the *Valorous*—for the purpose of carrying stores and supplies to fill up the other two in Greenland, and to place the remainder of her cargo in dépôts on shore, for any further needs.

As stated, the fleet left Portsmouth on the 29th of May. The first ice was seen on the 27th of June, and on the 6th of July the *Alert* and *Discovery* anchored in the harbor of Godhaven, at the southwest end of Disco, where the *Valorous* had arrived two days before. Here the two exploring vessels were occupied from the 6th to the 15th in filling up with coal and provisions from the *Valorous;* and on the afternoon of that day they proceeded on their journey, stopping by the way to procure dogs, of which twenty-four were taken on board at Godhaven and twenty more at Ritenbeck.

On the 17th the *Alert* and *Discovery* left Ritenbeck, and the *Valorous* started on her voyage homeward.

On the 19th of July the two former vessels reached the little Danish settlement of Proven, where Esquimau Hans, well known in connection with the *Polaris* expedition, was engaged. Fortunately for the expedition, he consented to go without his wife and children, thus relieving it from a very considerable burden. Here, also, some additional dogs were procured, bringing the total number up to sixty-one.

Information was here obtained in regard to the condition of the ice, and it was learned that the whalers had not been able to get through Melville Bay at first, but that they managed to accomplish this on a second attempt in the second week of June.

Leaving Proven on the 21st of July, they reached Upernavik on the 22d, and, after remaining only two hours, sailed at 8 A.M. of the same day. These are the latest advices received from the expedition, which is now doubtless in comfortable winter-quarters, engaged in prosecuting the researches assigned to it.

The *Pandora*, under command of Captain Young, which sailed in the spring for the purpose of making additional discoveries in regard to the northwest passage, and particularly to obtain further relics of Sir John Franklin, returned to England on the 16th of October, without having accomplished her mission. She expects, however, to start out again in the coming spring.

Disco was reached on the 7th of August, and Upernavik on the 13th, and Cape York on the 16th. The vessel called at the Carey Islands and deposited letters for the *Alert* and *Discovery*, and thence proceeded up Lancaster Sound to Beechey Island, which was reached on the 26th. Here Northumberland House, which was built as a storehouse by the *North Star* in 1850, was inspected, and it was found that it had been broken open by bears and many of the stores damaged, except those in casks and barrels. The two life-boats and the yacht *Mary*, left by Sir John Ross, were found in perfect condition.

After putting the dépôt in order, Captain Young proceeded up Peel Strait for the purpose of reaching King William Land, getting as far as La Roquette Island, near Bellot Strait, on the 30th of August. Here an impenetrable pack of ice across the channel barred all further progress, and, after vainly trying to find a passage, Captain Young prudently determined to retreat, which he did on the 3d of September, and, as stated, the *Pandora* reached home on the 16th of October.

In point of actual results in arctic research during the year, the expedition of the *Pröven*, under command of Professor Nordenskjöld, has been the most successful, problems having been solved which have baffled inquiry for hundreds of years, and a rich harvest of physical and biological results secured. The *Pröven*, on which the party embarked, left Tromsö on the 8th of June, 1875, but was compelled to lie at anchor five days on account of a head-wind. Finally it got under way, and passed North Cape on the 17th, to the southern part of Nova Zembla, where anchor was cast in a bay north of Goose Cape. During the voyage numerous determinations of temperature and soundings were taken, and many collections made, promising many new objects to the naturalist.

From Nova Zembla the *Pröven* proceeded to the Sea of Kara, and on the 26th of July anchored off Waigat Island. It was not until the 30th that a boat could land on the island, on account of a storm. Here many rare silurian fossils were gathered, very similar to those of Gotland. The party met some of the Samoyedes, who had collected to see the vessel.

On the 2d of August the Sea of Kara was reached, and found to be completely free of ice; but, in consequence of the baffling winds, progress toward the middle of the peninsula, called by the natives Jalmal, which separates the Sea of Kara from the Bay of Obi, was very slow. This delay, however, was utilized in making many collections of animals, among which were several new species. The water at the surface, in consequence of the large rivers emptying in the vicinity, proved to be nearly free from salt, forming a deadly poison for the animals which live in the salt-water at the bottom. Most of these when brought up from the bottom died when placed in water from the surface.

An important series of experiments was made with the Negretti-Zambra and Casella deep-sea self-registering thermometers, showing that in the Sea of Kara, as well as off the coast of Nova Zembla, the temperature of the sea-water at the surface is very variable, and dependent upon the temperature of the air, upon the neighborhood of ice, and upon the influx of warm fresh-water from the Obi and Yenisei, but that at the depth of ten fathoms the temperature is nearly or quite constant (between 1° and 2° C.). If in the northern part of the Sea of Kara, where the water on the surface is almost completely free of salt, and at this time of the year very warm, a flask filled with water from the surface is sunk to a depth of ten fathoms, the water becomes frozen. There are thus no warm-water ocean currents here at any considerable depth below the surface. It is believed that the percentage of salt at the bottom is very constant.

On the 8th of August the party landed for a few hours on the northwestern side of Jalmal, where an astronomical determination of the position of the place was made. Traces of men and of Samoyede sledges were visible on the beach. Close to the shore was found a sacrificial altar, consisting of about fifty skulls and bones of the polar bear, walrus, and reindeer. In the middle of this heap of bones were two rude idols, hewn from drift-wood roots, newly besmeared in the eyes and mouth with blood; also two poles provided with hooks, from which hung bones of the reindeer and bear. Close by was a fireplace and a heap of reindeer bones, the latter clearly the remnant of a sacrificial meal.

After a stay of a few hours, the party set sail for the north, until farther advance was prevented by impassable masses of great even ice-fields at 75° 30′ north latitude, and 79° 30′ east longitude. Following the edge of the ice eastward, they finally reached the north side of the mouth of the river Yenisei on the 15th, and they had now attained the goal which great seafaring nations had striven in vain for centuries to reach.

Here the vessel remained engaged in various occupations until August 19, when she proceeded to the northern part of Nova Zembla, and on the 23d of August reached 75° 24′ north latitude and 66° 24′ east longitude—a little south of Cape Middendorff, on the northeast coast of Nova Zembla.

This was the result of a very strong northwesterly current from the Obi and Yenisei out over the Kara Sea.

At Cape Middendorf ice was met with, extending as far as the eye could reach, and the expedition was becalmed for six days, during which time very rich results were obtained by means of the dredge and trawl. Animal life was found to be very abundant and varied; enormous numbers of radiates, crustaceans, and mollusks were taken in a short time. On the 29th anchor was cast in Udde Bay, where marine vegetation was found to be very abundant, contrasting strongly with the scanty land flora.

On the 3d of September the *Pröven* sailed into the mouth of Matotschkin Strait, where the party remained until the 11th of the month, and thence proceeded homeward, experiencing exceedingly tempestuous weather, and arriving at Tromsö October 3d. The vessel sailed over six thousand miles, and visited regions which expeditions for more than three hundred years had vainly attempted to reach, making rich collections in all departments of natural history.

In the mean time Professor Nordenskjöld left the steamer at Port Dixon, and proceeded up the Yenisei in a boat, accompanied by five men, making a very interesting exploration of the river. At the last advices the Professor had reached St. Petersburg (November 27), on his homeward journey, where he was received with the utmost hospitality by the scientific men of the capital. His return to Stockholm has not yet been announced.

In further reference to this subject of arctic discovery, it is stated that Captain Gundersen, recently returned from a voyage to Nova Zembla, found there the journal of Barent, giving an account of his doings from the 1st of June to the 29th of August, 1580.

North America.—For several years past, as shown by the successive volumes of the *Annual Record*, a large part of the activity in exploration in North America has been due to the labors of three government parties; two of them, those of Professor F. V. Hayden and Major J. W. Powell, acting under the Interior Department, and the third, that of Lieutenant George M. Wheeler under the Engineer Bureau of the War Department. The operations of these parties have generally been conducted on a very large scale, provided with the necessary *personnel* and apparatus for prosecuting researches in geodesy, topography, geology, as well as natural history and ethnology, resulting not only in the accumulation of a large mass of facts, but of many interesting and important specimens as well. The former have been promptly worked up into annual reports of progress, and the latter deposited in the National Museum, in accordance with the act of Congress to that effect, where they occupy a very conspicuous place.

Detailed reports of the labors for the year of these several parties, as furnished by the officers in charge, will be found in the body of the present work, rendering it unnecessary to say any thing further here upon the subject. The final reports of these expeditions, however, deserve further mention. These will be, for the most part, in quarto, and the series for each will embrace about six volumes, some of which are already published. Of Professor Hayden's survey there have already appeared: "The *Acrididæ* of North America," by Professor Cyrus Thomas; "The Extinct Vertebrata of the West," by Dr. Joseph Leidy; "The Cretaceous Flora of the West," by Professor Leo Lesquereux; and "The Cretaceous Vertebrata of the West," by Professor E. D. Cope, the last mentioned having been published in 1875. Several volumes of Lieutenant Wheeler's series are in press, and will be published in the course of 1876. The first volume of Major Powell's report, that on his exploration of the Colorado River in 1869–72, appeared during 1875.

Apart from the labors of the three great expeditions there have been less than usual of miscellaneous explorations in the United States in 1875. In this connection, however, we may mention the labors of the United States Fish Commission at Wood's Hole, Mass. A party, composed as usual of several scientific specialists, established itself at that station, where, with the assistance of the apparatus of the Commission and of the United States steamer *Blue Light*, furnished for its use by the Navy Department, and under command of Captain L. A. Beardslee, a large amount of scientific work was accomplished, including a thorough exploration of the shores of Nantucket, Martha's Vineyard, and the south side of Cape Cod for a considerable distance, as well as of the intervening waters.

Among the gentlemen present were Professor A. E. Verrill, S. J. Smith, and S. F. Clarke, of Yale College; Dr. William G. Farlow, of Cambridge; Professor A. Hyatt, of Boston; Professor Theodore Gill, Mr. G. Brown Goode, and Mr. T. H. Bean, of the Smithsonian Institution; Professor Sanderson Smith, of New York; and Dr. J. G. Kidder, surgeon of the *Blue Light*, and numerous occasional visitors of distinction. The collections were very large, embracing a full representation of the marine life of the region referred to.

A large part of the work of the Commission was devoted to obtaining illustrations of the fisheries of Massachusetts, for exhibition at the International Exposition, including the work of securing photographs, colored sketches, and plaster casts of the cetaceans and fishes generally, either originals or models of the various forms of fishing-craft and of the apparatus used in the fishery business.

Although not coming under the head of geographical explorations, it may be proper to make special mention of sundry ethnological researches, connected with the preparations for the International Exposition, and conducted, for the most part, under the auspices of the Smithsonian Institution and of the Indian Bureau. The first of these to be mentioned is the work of Mr. Paul Schumacher on the islands and mainlands in the vicinity of Santa Barbara, where, with a party of several assistants, he was engaged for several months in making explorations of the graves of the aboriginal inhabitants.

A party, detailed by Lieutenant Wheeler, under Dr. H. C. Yarrow, was also engaged simultaneously, in the same region, for the same object.

After the labors of Mr. Schumacher in the Santa Barbara region were brought to an end, the work was taken up by Rev. Stephen Bowers, and from the three parties an enormous aggregate of interesting objects, and of remarkable variety and beauty, were sent to Washington—the whole reaching a weight of over fifteen tons, composed principally of objects of stone, in the form of mortars, pestles, bowls, plates, etc. Mr. Schumacher subsequently continued his researches in Oregon with satisfactory results.

Mr. James G. Swan, of Port Townsend, was engaged by the Indian Bureau to prosecute researches into the ethnology of the Indians of Northwestern America, for which purpose he visited Alaska and various points on Puget Sound. Large collections were made by him and shipped to Washington.

Mr. Stephen Powers, well known from his researches into the Indianology of California, was also engaged by the Indian Bureau to make explorations in California and Nevada in search of ethnological objects.

Major J. W. Powell, in addition to his surveying work, made many collections, illustrating Indian life, of pre-eminent value.

The ethnological inquiries of Dr. Edward Palmer in the southwestern portion of the United States, especially in the vicinity of San Diego, have furnished satisfactory returns.

In addition to these more extended and noteworthy researches, numerous investigations of less importance have been prosecuted in the Mississippi Valley and elsewhere, yielding very gratifying results.

For the purpose of securing a proper representation at the International Exposition of the tribes of Northern Alaska, the services of Dr. Bessels were engaged by the Indian Bureau, and the occasion of a cruise of the United States steamer *Saranac*, in northern waters, was embraced by him, with the permission of the Secretary of the Navy, to proceed to the North, for the purpose of making full and exhaustive collections. Unfortunately, the *Saranac* was wrecked not far from Victoria and totally lost, thus putting a summary end to the expedition.

For further information relative to explorations in North America in 1875, reference may be made to the chapter on Geography in the body of this work.

There is little to be said in regard to the work of exploration in Central and South America during the past year. The *Narragansett*, as already mentioned, under Commander Dewey, performed good service in the waters of Lower California and the west coast of Mexico, the results of which have been published in the form of a report.

The labors of Professor Gabb in Costa Rica have been brought to a close, and that gentleman is now engaged in working up his collections and notes, with a view to an exhaustive report, interrupted for a time by a visit to San Domingo. The extent of his collections in general natural history and zoology has seldom been equaled, and we may safely say that, so far as the vertebrates are concerned, the zoology of Costa Rica is almost as well known as that of the United States. His work in reference to the ethnology of the tribes has also been extremely important. A full series of his collections, biological and ethnological, has been placed by Dr. Gabb in the National Museum at Washington.

Asia.—The *London Geographical Magazine*, which constitutes so complete and exhaustive an exponent of geographical progress, in reviewing the third edition of Colonel Walker's map of Turkistan, takes occasion to give a statement of our knowledge of the progress of geography in Central Asia within the last two years. It remarks that the work of the mission to Kashgaria, under Sir Douglas Forsyth, is especially full of important results, among which are enumerated the correct fixing of the position of certain important towns by astronomical observations, and the survey of about three thousand miles of route lines. The longitude of Kashgar was established at 76° 6′ 47″ east of Greenwich.

Numerous changes of the previous geography in Central Asia, also, resulted from the labors of the Havildar employed on the great trigonometrical survey of the region of the Oxus, with the aid of a Mollah, an assistant of the Havildar.

Another exploration, the materials of which are made use of in Colonel Walker's map, is that in Great Thibet, by the Pandit who was connected with the expedition of Major Montgomerie.

The same journal also furnishes an account of the Olena expedition of the Russian Geographical Society, which left Irkutsk, under the direction of Cherandoski and Müller, in 1873, for the purpose of penetrating to the sources of the Olena River, and thence to the shores of the Arctic Ocean. This was carried on with varying success, and on the 1st of November, 1874, the travelers reached the mouth of the Olena, having thus completed the first part of the enterprise.

No very recent information has been published in regard to the operations of the present year, but it was expected that the basins of the Anabara and Khatanga would be investigated.

This expedition has added a great deal to the knowledge of the geography of Siberia, and the magnetical observations have developed the important fact that the Siberian pole of greatest intensity is between latitude 64° and 65° north and in about longitude 112° east, and just about 7° west and south of the position assigned to it by Gauss. The minimum temperature observed during the expedition was —49°, in latitude 61° 30′ north; the absolute maximum was 82.36°, on the 1st of June, in latitude 66° 26′. The expedition crossed the polar limits of several trees. The silver-poplar first disappeared, then the silver-fir, in latitude 60° 50′. The birch was found as far north as latitude 63° only.

Details in reference to the geographical discoveries in Northern Asia will be found in the account of Professor Nordenskjöld's journey to the river Yenisei.

A British expedition left Rangoon in the latter part of December, 1874, to re-open the old trade route between Burmah and Yunan. This was in charge of Colonel Horace Brown, accompanied by Mr. Ney Elias as topographer and John Anderson, director of the Museum of Calcutta, as medical director and naturalist. The party was accompanied by an escort of soldiers, and provided with Chinese interpreters and a guard. We learn, however, that after the expedition had reached the borders of China it was attacked by fanatical natives and entirely broken up, so that nothing was accomplished.

Nothing definite has been received in the United States in regard to the expedition to Western China, under the command of Captain Sosnovsky and Captain Matvosovsky, accompanied by a surgeon, photographer, and interpreter. They reached Shanghai by way of Kiachta and Pekin, and were to leave Hankow by steamer, and afterward to proceed westerly up the river Han in native boats.

The two explorations of Palestine, the one under American auspices and the other under British, have been continuing their work during the year with varying success. The British party in the early part of the year engaged in the examination of the southern portion of their field, which they expected to finish during the summer. At that time Lieutenant Condon reported that he had a list of nearly 3000 names in Arabic, and that he had fully identified Bethabara as the place where John was baptized. Upward of fifty fords of the Jordan were discovered in the progress of the survey. Subsequently to that date, an attack by Arabs upon the party resulted in its temporary disorganization and a serious interruption to its labors.

The American party has also been doing good work. Reinforcements were sent out, under the direction of the American Palestine Exploration Society, from New York, on the 19th of June, on board of the steamer *Celtic.* The party consisted of Colonel J. C. Lane, of Brooklyn, commanding the expedition, J. Harvey Trent, of Lawrence, Massachusetts, and Professor Selah Merrill, of Andover. They were to be joined in Europe by Mr. Rudolph Meyer, who has preceded the party to make some preliminary arrangements. They took out a large supply of engineering instruments of American make, and will remain two years in Palestine, the expenses being guaranteed by the friends of the society.

Africa.—The interest in the exploration of this part of the world centres mainly around the labors of Mr. H. M. Stanley and of Lieutenant Cameron. It will be remembered that after his successful search for Dr. Livingstone, Mr. Stanley returned to the United States, and subsequently undertook a second exploration of the interior of Africa under the joint auspices of the London *Daily Telegraph* and the New York *Herald.* Starting in at Zanzibar in 1873, Mr. Stanley reached the Victoria Nyanza in 103 days, after a march of 720 miles, having experienced great hardships on the route, and the loss by disease and fighting with the natives of more than half his party. In further detail of this trip it is to be mentioned that at the village of Muhalala, in the district of Usandawi, the guides whom he had engaged at Ugogo deserted and left him in the wilderness. The march thence was an extremely trying one, and six of his men died; and when he at last reached Uveriveri the whole of his men were exhausted by hunger and fatigue. Failing to obtain sufficient supplies at this point, Stanley sent twenty of his party to Suna for a supply of grain. They succeeded in their mission; but during their absence two more men died.

On the 21st of January Stanley reached the village of Vinyata, in the district of Iturn, and in the valley of the Liwumba River, which he considers the most southerly source of the Nile known. It flows toward the west, and where he reached it there were numerous villages surrounded by plantations, having a population of from two to three thousand souls. After a time the inhabitants were induced to supply provisions; but the sight of Stanley's stores led to an attack on his camp, which was repulsed with a loss of fifteen on the part of the enemy. A second attack was also repulsed, when Stanley sent out four parties with orders to destroy the villages and to seize the cattle. He lost at this time twenty-one men, and on the 23d he left with a stock of provisions for six days.

On the 28th he reached Mgongo Membo, in Iramba, where he found that out of the 314 men with whom he left the coast only 194 remained. Proceeding farther toward the lake, and penetrating through the jungle bounding the western side of the basin of what is apparently an arm of the Nyanza, Stanley entered Usukuma, which he describes as a densely populated country, abounding in cattle, and finally reached the Nyanza on the 27th of February, 1875, at Kagehyi, one of the principal ports resorted to by slave-dealers, in the district of Uchambi. Here his force numbered only three Europeans and 166 natives. A careful discussion of the temperature of the boiling point indicated an altitude of 3808 feet, the aneroid giving 3550 to 3675 feet.

At Kagehyi Mr. Stanley launched a light boat which he had carried in pieces from the coast, and embarking on the 8th of March, with a picked crew, he circumnavigated the lake in 57 days. He found the physical aspect of the shores to vary considerably, in places being quite high, and again composed of marshy plains. The island of Ukerewe, perhaps the largest in the lake, was found to abound in cattle and ivory. As his circumnavigation continued, numerous encounters took place with the natives, in all of which Stanley was victorious.

At Beyal Island Stanley was welcomed by a fleet of canoes, sent by King M'tesa, of whom he speaks in the highest terms. The king and his officers now profess Islamism, and dress in Arab costume; but he is, nevertheless, said to be anxious to receive Christian missionaries. The daily butchery of men and women has been stopped entirely. On this expedition Mr. Stanley had the good fortune to meet M. Linant de Bellefonds, one of Colonel Gordon's officers, to whom he intrusted a letter. This young officer, with thirty-six of his followers, was massacred by the Bari on his return to the north, and Stanley's letter was flung aside, but was afterward found by a detachment sent out by Colonel Gordon.

On the 17th of April Stanley left Murchison Bay, on his return to the south, and was accompanied by an escort as far as the Kotonga River. Leaving this river on the 20th of April, he returned to Kagehyi on the 5th of May, where he found that Frederick Baker, one of his European servants, had died on the 23d of April.

The area of Lake Nyanza is set down as 25,300 square miles. It is stated by the *Geographical Magazine* that Stanley's observations and those of Speke agree very closely, the difference in the estimates of the two explorers being very slight.

The result of the labors of Lieutenant Cameron is, if any thing, found to be more important than that of Stanley, as being through a less-known region, and solving a still greater geographical problem. This officer of the British service left the eastern coast, near Zanzibar, on the 24th of March, 1873, reached Ujiji on the 21st of February, 1874, left for the west coast on the 18th of May, 1874, and arrived at Loanda in November last. It appears that he was not able to follow the Congo on leaving Lake Tanganyika, but was obliged to take a more southerly course; but allows the inference that the lake is really the head of the Congo River, as recently maintained.

Nothing very definite appears to have been received from the expedition of Colonel Gordon, which had for its object, in part, the exploration of Lake Nyanza. No later advices have come to our knowledge than that of the arrival of Lieutenants Watson and others of his party at Gondokoro on the 8th of December, 1874. From that point they were to proceed to the exploration of the Nyanza in a boat previously prepared at a station near the falls that obstruct navigation between Gondokoro and the lake.

The official reports of the exploration of the Ogowai River by Messrs. Compiégne and Marche have been published by the Geographical Society of Paris. The London journals, however, do not consider the results of their labors as adding very materially to geographical discovery.

Some months ago it was stated that an expedition was shortly to leave England for the purpose of making a survey of the coast of Africa opposite the Canary Islands, with a view of finding a suitable position for a harbor and a commercial and missionary station; to enter into commercial arrangements with the native tribes; to inquire into their present means of commerce and the resources of the countries through which it is proposed to pass. It was proposed also to examine as far as practicable the sand-bar across the mouth of the River Belta, which is supposed to keep the waters of the Atlantic Ocean from flowing into the dry bed of the ancient inland sea; and also to obtain levels and other necessary information.

Mr. M'Kenzie, whose name has been previously mentioned in connection with the project of converting the interior of Northern Africa into an inland sea, from the west coast rather than the north, is director of the party.

Australia and Polynesia.—The most interesting advance in our knowledge of the region embraced within this district is that which relates to New Guinea, several expeditions having been engaged in exploring the accessible portions of the coast. In May last the bark *Chevert* was fitted out by Mr. William Macleay for the purpose of geographical and biological exploration; and, accompanied by a picked crew of twenty men, a physician, and four zoological and three botanical collectors, and provided with a steam-launch, he left on the 18th of that month. Their route was by way of Percy, Palm, Brookes, and Cape York Islands; and at the end of six weeks the *Chevert* dropped anchor off the mouth of the Katow River, close to the New Guinea village called Mobato. The steam-launch was then fitted out for an exploration up the Katow, which at its mouth is 200 yards wide. It was, however, impossible to proceed very high up, in consequence of the obstruction from the trees. Returning, and finding a second attempt impracticable, sail was made for Darnley Island, where some time was occupied in killing the large pigeons of Torres Strait. They then proceeded to Hall's Sound, on the east side of the Papuan Gulf, and anchored off Yule Island, where they found an Italian naturalist, D'Albertis, who has been engaged for so many years in the exploration of the northern coast of New Guinea.

From this point the *Chevert* proceeded to Somerset Island to await news from Sydney; but after a time, in consequence of some misunderstanding between the captain and the party on board the vessel, returned to Australia, without having accomplished the objects for which it started out.

About the same time the missionary steamer *Ellangowan*, having on board the Rev. Mr. Macfarlane, of the Straits Mission, accompanied by a naturalist, left Somerset for the southwest coast of New Guinea, and on the 1st of September reached the mouth of a large river, hitherto unknown, and which they called Baxter River, being one of the finest in New Guinea. Its mouth was one and a half miles wide, and the depth nine to twelve fathoms. The position is said to be 9° 8′ south latitude, 142° 18′ east longitude. At a distance of fifteen miles up the river it was fully half a mile wide, and the depth of water seven fathoms. As the vessel proceeded upward the river banks became bolder, and the timber assumed a formidable growth. The river still continued wide and deep, and at intervals was fed by tributaries of such size and appearance as to render it a matter for much discussion which stream to select. The up-river voyage extended to a distance of ninety miles from the sea. Here they saw birds-of-paradise, and killed a boa-serpent 15½ feet in length. A gigantic bird, the spread of whose wings was supposed to be 15 to 16 feet, was started to flight, but could not be captured.* The tracks of enormous wild animals were observed, one of them supposed to be a species of buffalo.

Further information in regard to Australia, Torres Strait, the southwest of New Guinea, and the western islands of the Luciad Archipelago, is furnished by the report of Captain John Moresby and his companions, in the British steamer *Basilisk*, which was engaged in 1873 and 1874 in surveying these regions.

Captain Moresby remarks that the natives of the southwest portion of New Guinea are copper-colored, about five feet three inches in height, and with good features. The hair of the men is worn frizzled out in a large mat, and ornamented with feathers; that of the women is always cut short. Both sexes go almost naked. Their weapons are wooden spears and swords, clubs, slings, and stone V-shaped hatchets; but no bows and arrows are seen among them.

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* These dimensions have probably been exaggerated, as D'Albertis has sent home what is doubtless the same bird—a species of eagle—which, though of great size, does not quite come up to the claims of the officers of the *Ellangowan*. This has lately been described by Salvadori as *Harpyopsis novæ guineæ*, closely allied to the Harpy eagles of South America, and, like them, living on small mammals. It measures 35 inches in length: wing, 19; tail, 16½; tarsus, 5¼; middle toe and claw, 3¾.—*Annali del Mus. Civico di Genova*, 1872, vii., 682.

Human jaw and spinal bones are worn as bracelets and ornaments, and the wearers appeared to wish to have it understood that they had eaten the original owners of the bones. The houses are built, after Malay fashion, on poles raised five or six feet from the ground, and consist of one large apartment, with peaked gable ends and a saddle roof. Dogs, cats, and pigs are kept; also tame cassowaries, birds, and a small species of opossum bear.

Their fishing-nets are similar to an English seine, with shell sinkers and light wood floats, and are from one to twenty fathoms in length. The material is made by the women, from the fibre of a small, nettle-like plant, and possesses the strength of ordinary seining twine.

MICROSCOPY.

I. MICROSCOPIC APPARATUS AND OBJECTIVES.

In a paper upon microscopic spectrum apparatus, by Mr. H. C. Sorby, and published in the *Monthly Microscopical Journal*, May, 1875, he proposes for the future to adopt the plan of expressing the position of the absorption bands in terms of wave-lengths, instead of referring to an arbitrary scale. He states that probably it is a true general law that when the spectrum of a substance contains a number of well-marked absorption bands, they are related to one another in a perfectly definite manner, and a far more uniform connection exists between the wave-length of their centres than between any other condition. When the relation between the bands in different closely connected compounds is observed by the wave-length method, a relation is recognized which would not be possible if any arbitrary scale were adopted, and this not only when the physical state is the *same*, but when the substance itself is *chemically* modified. In view of this relation between the spectra of compounds known to be related in a simple manner, and which can be changed one into the other, it becomes a question of much interest to consider whether, when we meet spectra having similar relations, the substances may not be in some way connected, although it may be impossible to convert one into the other. Mr. Sorby gives several striking examples of these equal ratios, though the actual wave-lengths are very different, produced by different coloring matters, and which appear to show that some simple but unknown molecular or chemical combination really exists between them.

A self-centring turn-table, by Mr. C. F. Cox, is described in the March number of the *Monthly Microscopical Journal*, which will meet a want often felt by those who bestow any care upon neatly mounting their preparations, and especially when cells are to be prepared for reception of opaque objects.

In the August number of the *Journal of the Quekett Microscopical Club* is a description of an ingenious arrangement for cleaning very thin covers without breaking them. It consists of a small tube of brass or steel, about an inch in diameter, and the same in height, into which fits loosely a weighted plug. To the lower end of this plug is cemented a piece of chamois leather. Another piece of leather is stretched upon a flat piece of wood or plate glass to form a pad, which completes the apparatus. The tube being placed upon the pad, the moistened thin cover is dropped into it, and the weighted plug placed on it; holding the tube well down on the pad, one can rub as much as necessary without any danger of breaking, the weight of the plug giving sufficient pressure to clean the glass. The manipulation is quite easy, and it is difficult to break the glass.

Mr. Wenham describes in the April number of the *Monthly Microscopical Journal* a new "Method of obtaining Oblique Vision of Surface Structure under the Highest Powers of the Microscope." He advises the use of slips of glass about four tenths of an inch wide, ground and polished at an angle at one edge. The object to be examined is placed upon the sloping plane. One of the slips is cemented to the ordinary three-by-one-inch slide, and the other slip being slid against it, the object will lie flat between the two inclines. It is necessary to have the two inclines to remove the objectionable color which would otherwise enter into the objective. He recommends an angle of 35° for dry and 45° for balsam-mounted objects. These prismatic slips can be cheaply and easily made by grinding and polishing, say, a hundred at a time, and will no doubt be brought often into use in deciding whether certain appearances in the ordinary mode of view are or are not illusory.

In the April number of the *American Naturalist* is a description of a simple "spring clip" for use in mounting microscopic objects, the invention of Mr. N. N. Mason, of Providence, Rhode Island.

We learn from a contemporary that in order to facilitate the microscopical examination of the eye in cases of disease, M. Monoyer has contrived a modification of Siebel's ophthalmoscope, so arranged that three persons can make simultaneous observations.

Dr. Golding Bird, in an article in the *Quarterly Journal of Microscopical Science*, January, 1875, strongly advocates embedding in elder pith for the purpose of making microscopical sections. He employs for this purpose the pith of the common elder; it is split longitudinally, and a small furrow made with the finger-nail on the cut surfaces of each half, somewhat corresponding in depth to the thickness of the tissue to be cut, receives the specimen; it is then placed in the microtome, and put into water; in a few minutes the pith will have swollen sufficiently to hold the specimen firmly in its place, and the sections are made by means of a razor dipped into spirit.

Wenham's Reflex Illuminator.—Mr. Samuel Wells writes as follows to the *Boston Journal of Chemistry*, June, 1875: "I find that some immersion objectives are capable of transmitting the extremely oblique rays that pass through the illuminator so as to give a bright field when used on balsam slides. In dry mounts the light can not be transmitted beyond the upper surface of the slide, but in balsam-mounted slides the light passes to the upper surface of the cover and is there totally reflected. If an immersion objective is adjusted and connected with the cover by a film of water, the total reflection will be destroyed, and the light will pass through the cover and water into the front of the objective. The ultimate direction of the ray of light after passing through the illuminator is not changed by the introduction of the different media (balsam, glass, and water), and the angle at which it enters the objective must therefore be greater than 41°. In examining Möller's *Probe-Platte*, a balsam mount, under these conditions, with light from a kerosene hand-lamp, I easily resolved the *Amphipleura pellucida;* so clear and decided were the lines that with a power of 8000 they were still visible.

"The resolution of this difficult diatom, as well as the *Frustulia Saxonica* and *Nitzschia curvula* (Nos. 18 and 19 on the *Probe-Platte*), far surpasses any that I have ever seen by artificial light, and rivals the beautiful resolution obtained by monochromatic sunlight. With this illuminator it is much easier to resolve the *Amphipleura* in balsam than to resolve it dry with any other artificial illumination. The advantages of the reflex illuminator in thus furnishing light of greater obliquity than has been obtained by other methods seem to me worth considering by those interested in testing the resolving power of objectives.

"It is advantageous to connect the illuminator with the slide by glycerin, instead of water, as it does not evaporate. The higher refractive power of glycerin makes no difference in the ultimate direction of the light.

"With high amplification the lines of the *Amphipleura* become decidedly beaded, but do not separate into dots."

We commend to the careful reading of microscopists and microscope-makers the excellent paper of Mr. Slack, read before the Royal Microscopical Society of London, May 5, 1875, and the discussion thereon, contained in the June number of the *Monthly Microscopical Journal.* The paper is entitled, "On Angle of Aperture in Relation to Surface Markings and Accurate Vision." Mr. Slack proves, from the results already accomplished by Zeiss, of Jena, working under the direction of Professor Abbe, that resolving power and penetration are not in that condition of irreconcilable hostility generally supposed, and that a new era is dawning upon physiologists, and, indeed, all who care for something more than the mere display of diatom dots. It is well known that in the extravagant desire to display these dots angular aperture has been pushed to an extreme, and a certain amount of chromatic error allowed as necessary to sharpest definition. By very careful construction, centring, and elimination of errors, the objectives of Zeiss, *e. g.*, a one-quarter inch of forty-eight degrees, and a one-sixth inch of sixty-eight degrees, will perform work, as Mr. Slack proves, hitherto supposed to be only within reach of the most expensive large-angle objectives. Zeiss has, so to speak, minimized angles of aperture, and secured great working distance and penetration, and yet obtained the amount of separating and resolving power of much larger angled objectives. Mr. Slack truly observes that opticians have been encouraged to make excessive apertures substitutes for good corrections, and that naturalists and physiologists have been too contented with feeble resolving powers, under the belief that any more capacity for resolution must mean less penetration.

Not indirectly connected with this subject of large angle is the "Measurement of the Möller Probe-Platte," by Professor E. W. Morley, reported by J. E. Smith, in the same journal. The measurements were made by means of a Tollés one-sixteenth and a Troughton and Sims micrometer. Professor Morley's measurements are, no doubt, pretty accurate, but any one who knows any thing about diatoms also knows that the number of striæ in 0.01 inch, is subject to considerable variation in the same species. In a communication to the Memphis Microscopical Society, he states as a result of his measurements of the striæ of *Amphipleura pellucida* that they number 92,600 to the linear inch.

The perfection of objectives is yet far from being attained, as we have now Mr. Tolles, with his new system one-tenth surpassing the best work hitherto even with his one-fiftieth; and Messrs. Powell and Lealand, at a recent soirée of the Royal Microscopical Society exhibited a one-fourth and a one-eighth on a new formula, the first resolving *Amphipleura pellucida*, and the other showing *Pleurosigma angulatum* × 4000, under the most difficult test of direct light, in a remarkably magnificent manner, the beads standing out like minute spheres. At the same meeting Messrs. Beck exhibited a large microscope in solid silver, fitted with every conceivable piece of apparatus, all in silver. This luxurious work of art, intended for an American microscopist, cost some £500.

In the *Monthly Microscopical Journal* for February, 1875, is an important paper by Dr. Pigott on the invisibility of minute bodies, subtending a sufficient visual angle to be readily seen if properly defined. This invisibility depends upon several causes, which are examined, and the results given in detail; and, first, for minute gas bubbles (vacuum bubbles?) in plate glass: these examined by the horizontal microscope, placed opposite the window, give a very perfect picture of the prospect in miniature; the field of view precisely *three fifths* of the diameter of the bubble, and the marginal band *one fifth*—the same for all objectives, *whatever be the aperture.* Not so with a solid spherule of the same size and same glass, for, first, the marginal band increases in breadth from nothing till it occupies the whole spherule as the aperture is diminished; and, second, the degree of aperture at which the band first appears varies with the refractive index of the bead. If a small spherule be formed by melting the end of a fine glass thread, and examined under the microscope, using the plane mirror before a window, a minute image of the window appears, *surrounded by a black annulus*, which Dr. Pigott calls the "black test-band," it will be found that for the same aperture *the breadth of the black ring is exactly in the same proportion* to the diameters of the spherules; the angular aperture is at once shown by the breadth of the *picture* displayed within the spherule. On increasing the aperture the picture becomes larger and larger, until with a large aperture the ring is attenuated exceedingly; and upon diminishing the aperture exceedingly, the test-band widens so much that only a minute picture is left in the centre. It is evident that this test-band has a remarkable effect upon definition. If we are observing minute spherules in a mass, with excessive aperture, the bands become almost invisible, the forms of closely packed beading, if refractive and transparent, can not be descried, and if there be brilliant illumination, the forms under inspection are completely obliterated.

The Rev. Dr. Edwards, of St. Chad's College, Denstone, England, proposes for the unit of linear measurement in microscopical observations the wave-length of, say, yellow light, or, perhaps better, of orange; in this latter case we would have 1,500,000 wave-lengths = 36 inches, and, in round numbers, 1 wave-length = the $\frac{1}{40000}$ of an English inch. He states, with true English pertinacity, that though the Committee of the British Association have from time to time recommended the French meter for the unit, Englishmen will not become Frenchmen, and adopt a unit that theoretically holds good only when measured across the territory of the French republic.

The artificial production of silica films, with a view of adding to our knowledge of high power definition, and possibly throwing light upon questions of crystallization and organization, has received a new impulse in Mr. Slack's discovery that the gas escaping from a heated mixture of powdered glass, powdered fluor-spar, and sulphuric acid (and which, when received into pure water, deposits the silica suddenly and violently in amorphous particles), gives delicate films with definite forms, exhibiting remarkable regularity of size and arrangement when conducted through a mixture of glycerin and water. Some of the films produce the beautiful polychromatic effects so often noticed in beaded diatoms and scales.

In the August number of the *Monthly Microscopical Journal* is a paper by Dr. George D. Beatty, of Baltimore, reprinted from the Cincinnati *Medical News*, on "Double Staining of Wood and other Vegetable Substances." The author states that benzol fixes the anilines when used in staining tissues, and also renders them transparent. The double staining the spiral vessels, *e. g.*, of leaves red, and the other parts purple or blue, is obtained by immersing the section for five or ten minutes in an alcoholic solution of roseine (Magenta), and afterward in Nicholson's soluble pure blue for thirty or ninety seconds, rarely longer, with examination during this time to decide upon the proper instant for fixation by immersing in the benzol. We commend the article to those interested in this subject.

Blood.—In a paper read at a late meeting of the Zoological Society, Professor Gulliver stated that in the mammalia the largest red corpuscles of the blood are those of the two elephants, the two-toed sloth, and the walrus. In the human subject the corpuscles are exceeded in size by those of only eight or nine exotic mammalia, and not equaled in size by the corpuscles of any British animals of the class. And this fact, independently of its physiological interest, may prove important in medico-legal inquiries, since by it alone, as Dr. Joseph G. Richardson states (and as we have already noticed), he has correctly distinguished dried stains of human blood from those of the ox and sheep.

In the September number of the *Monthly Microscopical Journal* is a paper by Dr. Osler, "On the Organisms in the Liquor Sanguinis;" it was read at a meeting of the Royal Society, and has elicited considerable notice. He was not able to trace any organic continuity with any other recognized animal or vegetable form, or to show that they possessed power of reproduction, or were at all related to *Bacteria*.

Dr. Joseph G. Richardson, in a paper presented to the Royal Microscopical Society, and published in the January number of the *Journal*, makes the strong statement that the "pigment-cells," or "scales," described by Frerichs, of Berlin, as occurring in blood, and the "pigmentary particles," or celloids, figured by Dr. Roberts, of Manchester, England, in his treatise on "Urinary and Venal Diseases," are simply and solely *accumulations of dirt*, especially the remains of blood corpuscles, in the little excavations on slides in ordinary use! This is a strong statement, and worthy of serious consideration; but Dr. Richardson is so confident of the truth of his assertion that he challenges any devout believer in pigment-flakes to bring him an honest specimen of blood or urine from any ordinary case of disease, in which can be demonstrated either pigment-flakes, pigmentary particles, or pigment-scales.

M. Laptschinsky, of St. Petersburg, contributes a paper to the *Centralblatt* on the microscopic changes undergone by the blood in various diseases. Where febrile symptoms are present, the changes consist in the blood-corpuscles not running into regularly formed rouleaux, but in accumulating in heaps or clumps, while the individual corpuscles frequently appear swollen and cloudy. In the interspaces of the clumps of red corpuscles, great numbers of white corpuscles may be seen. Careful enumeration of the relative numbers of white and red corpuscles, the former showing unusually active and extensive amœboid movements, satisfied him that in febrile diseases, and in Bright's disease, the conversion or development of white corpuscles into red is either materially retarded or entirely arrested.

The Microscope in Geology.—A valuable paper on the microscopic rock-structure of some ancient and modern volcanic rocks was lately read before the Geological Society by Mr. J. Clifton Ward. In this paper he gives the details of structure of some modern lavas, showing that even in such modern lava-flows as that of the Solfatara, considerable changes had taken place by alteration, and the replacement of one mineral by another, and this very generally in successive layers corresponding to the crystal outlines. With regard to the ancient lavas and ashes of Cumberland of lower Silurian age, they resembled the Solfatara graystone, and though in external structure having more of a felditic than a basaltic appearance, in internal structure they have considerable analogies with the basalts, while in chemical composition they are neither true basalts nor true felstones.

In the case of the Cumbrian ash-rocks the most intense metamorphism had taken place; and the author states that neither the careful inspection of hand-specimens, nor the microscopic examination of thin slices, would in all cases enable truthful results to be arrived at, but that these methods and that of chemical analysis must be accompanied by a laborious and detailed survey of the rocks in the open country.

Botany.—We notice as worthy of attention the articles now in course of publication in the *Monthly Microscopical Journal*, by Thomas Taylor, microscopist of the United States Department of Agriculture, "upon certain fungi parasitic on plants." In the March number he describes the "black knot" of cherry and plum trees, and the *Oidium tuckeri* found on the vine. The latter appears to be not a true mould, but merely a condition of *Erysiphe*, a true parasite of the vine, which will not fruit when removed from the plant on which it grows.

Hitherto no Diatomaceæ are certainly known to have been found earlier than in tertiary deposits. The few so-called diatoms found by Dr. White in the hornstone of the Devonian are exceedingly doubtful. We should scarcely expect silica imbedded in silica to be very visible. Very recently Count F. Cartracane, a well-known microscopist, states, in the *Naturforscher*, that he has proved the existence of Diatomaceæ during the coal period. A piece of Lancashire coal was pulverized and exposed to a white heat; the decarbonized dust was treated with acid and chlorate of potassa, washed clean with distilled water, and placed under the microscope. Many diatoms, almost exclusively fresh-water genera, and species now living, were found. A piece of cannel-coal from Scotland and another from the St. Étienne mines gave the same result. The experiment needs repeating to prove that these organisms from the coal epoch to the present time have undergone no perceptible modification.

In the *Monthly Microscopical Journal* for September, 1875, is an interesting paper by Worthington G. Smith on the resting spores of the potato fungus, or the "new" potato disease, as it has been called, and he shows that it is no other than the old enemy in disguise, *Peronospora infestans*, in an unusual and excited condition. The article is well illustrated, and worthy the attention of microscopists interested in the study of these parasitic organisms. In the same journal is the conclusion of Dr. Bastian's address on the microscopic germ theory of disease, in which he insists that the facts already known abundantly suffice to displace the narrow and exclusive vital theory, and to re-establish a broader physico-chemical theory of fermentation, and that the original notion, borrowed from the vital theory of fermentation, that all the organisms met with in a fermenting mixture are strictly lineal descendants of those originally introduced as ferments, must disappear with the vital theory itself, and with it the old explanation of the mode of increase of contagium within the body.

A paper of some interest on the *sphæraphides* in plants appears in the *Monthly Microscopical Journal* for December, 1874. The author states that in *Urtica dioica*, *U. urens*, and *Parietaria diffusia* the leaf blades are studded with sphæraphides about $\frac{1}{532}$ of an inch in diameter, composed mainly of carbonate of lime; smaller forms, with projecting crystalline points, and composed of oxalate of lime, occur in the fibro-vascular bundles of the leaf; the same two kinds abound in the leaf and pith of *Humulus lupulus*.

Dr. Bastian delivered an address lately before the Pathological Society of London, on the microscopic germ theory of disease. The conclusion he has arrived at is opposed to the two forms of the "germ theory" of Dr. Sanderson and Dr. Beale, and, indeed, adverse to the holding of any germ theory in the only form in which it may be at all tenable. No doubt a lively discussion will be elicited, but we much doubt whether any conclusion acceptable to all will be arrived at.

Infusoriæ, etc.—At a recent meeting of the Academy of Natural Sciences in Philadelphia, Dr. Leidy described a curious rhizopod found in a mill-pond, and measuring $\frac{1}{100}$ of an inch in length. It moves slowly with a snail-like motion, and protrudes numerous papillæ and processes which bristle with rigid spicules, which can be shortened or withdrawn—a peculiarity that separates the animal so widely from its nearest ally that it probably belongs to a distinct genus. It is therefore named by Dr. Leidy *Dinamœba mirabilis*. A very curious and interesting discovery of what appear to be fresh-water polycystinæ has lately been made, and a paper embodying all at present known with regard to them may soon be expected from Mr. George W. Morehouse; hitherto they have been considered exclusively marine, and are found in the deepest sea soundings, where, either from the solution of the carbonate of lime or other cause, the foraminifera have entirely disappeared. The lamented Professor H. J. Clark published in 1866 in *Silliman's Journal* a paper in which he maintained that the sponge was an aggregation of flagellate infusoria, a compound protozoan animal; the same view had been substantially announced a little before by Mr. Carter. Haeckel has more recently modified this view, contending that the flagellate monads of Clark are simply cells lining the general stomach cavity of the sponge, and that therefore it is not a compound infusorian, but a more highly organized animal related to the radiates. He regards the sponges and acalephæ as having been evolved from a common ancestor, which he terms *Protascus*.

We note in the *Monthly Microscopical Journal* for May the completion of the excellent series of papers by Messrs. Dallinger and Drysdale, entitled "Researches into the Life History of the Monads." Five different forms of these have been thoroughly studied, and they name them respectively the *cercomonad*, the *springing monad*, the *uniflagellate*, the *biflagellate*, and the *calycine*, the latter so named from its peculiar calyx-like form. The authors state that the complete detail in the development of these monads was only successfully compassed by the one twenty-fifth and one fiftieth of Powell and Lealand, with diameters ranging from 2500 to 5000. They express a complete distrust of all observations founded on successive "dips" in a quickly changing organic infusion, and put no faith in observations of this sort, and not conducted on the plan of keeping the same drop under continuous observation during all alleged transformations. From their own observations on these lowly forms they are constrained to say "that not the slightest countenance is given to the doctrine of heterogenesis. On the contrary, they find the life cycle of a monad to be as rigidly circumscribed within definite limits as that of a mollusk or a bird. The heating experiments uniformly proved that the spores resulting from sexual generation have a power of resistance to heat over the adult, which is greater in the proportion of eleven to six on the average—the very essence of the question of biogenesis *versus* abiogenesis—some of the spores resisting 88° Fahr. above the boiling point of water. This result agrees with the experiments of Dr. W. Roberts, and later of Huitzinga, who could not destroy the bacteria or their germs by boiling for half an hour under a heat of 230° Fahr.

In the proceedings of the Philadelphia Academy, April, 1875, we find a paper by Dr. Leidy upon a curious rhizopod, which he terms *Biomyxa vagans*. He compares it to the reticular pseudopods of a *Gromia* separated from the body. The creature moved actively, and assumed the most varied forms. This curious rhizopod had already been observed, especially in connection with the Diatomaceæ. When, in moving along the stems of conferva, it encounters a group of diatoms—synedra, *e. g.*—instantly the whole mass spreads out and envelops them, and for hours remains motionless, except the movement of the internal granules. A partial solution of the silica is effected in the process of digestion; for after some hours an enveloping case, partially silicious, and which has formed during the interval, inclosing both rhizopod and diatoms, is ruptured, and in one or more streams the branching mass escapes, leaving the silicious case quite perceptible, and the diatoms so firmly fused together that severe treatment with acids will not separate them. Professor Leidy considers it sufficiently distinct to represent a genus, and it is certainly a remarkable object. It was, no doubt, a case of encysting of this kind upon which Dr. Bastian, in his "Beginnings of Life," founds his assertion of the resolution of *Euglena* into diatoms.

A paper was recently read before the Quekett Microscopical Club, by Mr. W. F. Woods, on the relation of *Bucephalus* to the cockle. He states that, in contradistinction to the opinion of M. Lacaze-Duthiers, who has described it as a cercarian form of some unknown *Distoma*, that either, first, the *Bucephalus* is the larva of the cockle (and if not, it remains an interesting question for solution what is), or, second, the *Bucephalus* is a parasite; but if so, it does not render the cockle sterile, as asserted by Lacaze-Duthiers; and, third, the connection of the tube with the ovisacs, as established by presence of eggs in both, proves that it is not an independent sporocyst, but an organ of the cockle; while, fourth, if this connection be denied, the *Bucephalus* must still be developed from eggs seen in the tube.

In contradistinction of a third assertion by Lacaze-Duthiers, Dr. Wallich writes as follows in the *Lancet* (June 12) on the subject of nutrition of the protozoan. He states that for fifteen years he has stood alone in maintaining that the law of nutrition which prevails in the case of the higher orders of the animal kingdom, and constitutes the fundamental distinction between it and the vegetable kingdom, fails in the case of the simplest and humblest creatures; and he expresses a belief that the lower rhizopods provide for their nutrition and growth by eliminating from the medium in which they live the *inorganic* elements that enter into the composition of their protoplasm, and that there is no hard-and-fast line between the two extremes of the two great kingdoms, but a gradual transition and overlapping from both sides. The results of deep-sea explorations, and especially the examinations of the *Tuscarora* soundings, do not confirm this view; the vegetable growths, even at extremest depths, proceed *pari passu* with the animal, and we see as yet no reason why the same provision that holds good in the case of the higher and terrestrial organisms should not be extended to the humblest marine or aqueous forms.

Professor Leidy has recently called attention to the parasite that lives in the proboscis of the house-fly, a thread-worm —*Filaria muscæ*—first discovered by the well-known naturalist Mr. J. H. Carter in the house-fly of India. Dr. Leidy found it in numbers from one to three in about one fly in five. Dr. Diesing has referred the parasite to a new genus, with the name *Habronema muscæ*. The singular position in which the worm lives suggests that there are many unsuspected places in which we may have to search to find the parents or offspring of our own parasites.

In a communication to the French Academy in November last, M. Duval, calling attention to a former paper in the *Journal de l'Anatomie*, September, 1874, states that he has found a means of explaining both the doctrines of the panspermists and the heterogenists. The explanation lies simply in the statement that he has discovered that the various so-called minute organisms (such as ferments) are simply one and the same organism, which has the power of becoming differently developed. He asserts that he has proved by experiment that the transformation of yeasts is possible, and that the specificity of action of different ferments is a purely relative phenomenon, dependent rather upon the composition or the state of the media than upon the proper constitution of these same organisms.

For ten years after the publication of Ehrenberg's "Infusionsthierchen," it was supposed that the Rotifera were all hermaphrodites. In 1848 Mr. Brightwell discovered a rotifer with separate sexes in the genus *Asplanchna;* in 1850 Mr. Gosse discovered the male of another species of the same genus, and in 1854 Dr. Leydig that of a third. Two years later Mr. Gosse figured in the "Philosophical Transactions" the males of several species of *Brachionus*, *Polisarthra*, *Synchæta*, and *Sacculus*. More recently Dr. C. T. Hudson has discovered the male of *Pedalion mirum*. Previously to this discovery it will be noticed that the others belong all to one group—the free swimming rotifers; and this caused Professor Huxley to consider the *Rotifera as permanent forms of echinoderm larvæ*, and his argument was hard to answer, for it rested on the supposed monœcious character of some of the largest and most common rotifers—creatures constantly watched and studied in consequence of their great size and beauty. The discovery of Mr. Hudson, especially of the male of *Lacinularia socialis*, weakens Mr. Huxley's argument considerably. And though it may possibly still be held desirable to rank the Rotifera among the Vermes, we can not reckon among the reasons their sexual resemblances to the echinoderms; and there is at least one, viz., *Pedalion*, which it seems impossible to class among the worms, for it has six hollow limbs worked by striated muscles, some of which pass freely through the cavity of the body.

II. BACTERIA.

Messrs. Dallinger and Drysdale, whose excellent researches on the life history of a monad have elicited universal commendation, have recently taken up the study of Bacteria. Using the new immersion, one-eighth of Powell and Lealand, an objective capable of resolving the striæ of *Amphipleura pellucida* into beads, as also the fine striæ of *Surirella gemma*, they find that *B. termo* is furnished at both ends with a flagellum, exquisitely delicate, and only to be discovered when in the proper position in regard to the light.

In an abstract of a paper by Dr. Hollis on "What is a Bacterium?" in the January number of the *Monthly Microscopical Journal*, the limitations we should place on the term Bacteria are summed up: 1. They strictly form part of the vegetable kingdom. 2. The name ought to be restricted to those minute rod-like hyaline bodies, *B. termo* and *B. lineolata* of Cohn, with a more or less rapid to-and-fro motion. 3. We must always associate the presence of true Bacteria (especially the *B. termo*) with putrefactive or analogous changes in organic liquids.

Development of Bacteria in Organic Tissues Protected from Air.—M. Servel recently read an interesting paper on this subject before the French Academy of Sciences. The first two experiments were upon Guinea-pigs; the live animals were decapitated so that the head fell at once into a chromic-acid bath. Examined six days after immersion, the outer parts were hard and preserved, but the cerebral parts were in manifest corruption, and the cerebral pulp, under the microscope, presented a large number of bacteria of all sizes. In these experiments the absence of air-germs was not sufficiently demonstrated, and M. Servel repeated them with the livers and kidneys of dogs, killed for this purpose by femoral bleeding. To eliminate sources of error, and especially entrance of air by the wound, he placed a ligature at the level of the hilum of the liver and kidney to be experimented on, the organs were removed, preserving their envelope of connective tissue, and the ligature was used to suspend the organs in the bath. Examination some days after showed that the surface was hardened throughout, but the central parts were full of bacteria; the chromic acid at once arrested their movement. Hence he concludes: 1. That MM. Bechamp and Estor's demonstration of the production and evolution of bacteria in organic tissues protected from air-germs is quite exact. 2. That the effect produced by preservative agents is the death of microzymes, or molecular elements surviving in the organs.

III. THE CHALLENGER AND TUSCARORA SOUNDINGS.

Dr. Wyville Thompson says, in his report in the Proceedings of the Royal Society, No. 156, that in latitude 60° 52′ south, longitude 80° 20′ east, also 53° 55′ south, and 108° 35′ east, the sounding instrument came up filled with a very fine cream-colored paste, which scarcely effervesced with acid, and dried into a very light impalpable white powder; examined under the microscope, it was found to consist almost entirely of the frustules of diatoms, many broken, and some wonderfully perfect; with these were rods of a singular silicious organism, hollow, and, as subsequently obtained floating by means of a tow net, a little to the north of the Heard Islands, containing the characteristic endochrome of the diatoms. The tow net was at this time filled with a pale yellow gelatinous mass of diatom ooze, and Professor Thompson, considering the bottom Diatomaceæ as dropped from this belt of diatom ooze, as he terms it, and which was found somewhat farther southward, attributes the difference of position to the reflux of the Agulhas current. The existence of diatom ooze over vast surfaces of the Pacific is abundantly proved from the soundings of the *Tuscarora*. Many of these consist of diatoms only, and as they are not in the semi-fossil condition of those obtained by the *Challenger*, but still with endochrome within the frustules, and the ooze itself of a yellowish-green tint, it is but fair to conclude that extensive belts of these organisms are still living at great depths, and serving the purpose, precisely after the manner of land plants, of eliminating carbonic acid, appropriating the carbon and giving forth the oxygen.

One of the finest yields of diatomaceæ, principally *Coscinodiscus omphalanthus*, *C. concavus*, *Asterolampra Brookei*, *Rhizosolenia hebetata*, and *Triceratrum arcticum*, was from latitude 52° 11′ north and longitude 176° 48′ east, from a depth of 1681 fathoms. Another cast, latitude 43° 47′ north, longitude 150° 2′ east, from a depth of 4234 fathoms, consisted almost entirely of diatomaceæ, principally *Coscinodiscus* and *Biddulphia.*

Among other interesting results from examination of the deep-sea soundings of the *Tuscarora*, we may mention the occurrence of undoubted living foraminifera, not derived surface forms, at a depth of 2711 fathoms. At this depth, as might be expected from the large amount of carbonic acid, no calcareous organisms could exist, and none, except a stray *globigerina*, too recently dropped to be dissolved, were found; but there were multitudes of sandy *Lagenidæ*, some very large; also *Lituoldiæ* (especially *L. canariensis*, and various *Trochamminæ* and *Dentalinæ*, with polished sandy tests like *Trochammina*). But the most noteworthy fact was the occurrence of *Orbulina*, not with calcareous or sand-incrusted calcareous tests, but with shells wholly of sand grains, and perfect in shape, too large and heavy to have ever floated. The abundance and character of all these forms, along with which were numerous sand tubes and great numbers of *Acanthometrinæ*, *Thallassicollinæ*, and *Polycystinæ*, preclude the idea of dropped surface forms. In another sounding, of 108 fathoms, were fine specimens of *Lingulina*, and some transparent enough to show distinctly the early growth, a rapidly increasing spiral, which is masked entirely in the fully developed, and more or less sandy rectilineal tests of the matured form. At a depth of 1625 fathoms, specimens were found of the genus *Ellipsoidina* of Professor Seguenza, hitherto only known as fossil from the miocene marls around Messina.

In a paper read before the Royal Society, November 26, 1874, by Professor C. Wyville Thompson, the origin of the calcareous formation known as "globigerina ooze" is attributed to surface organisms, as advocated by the late Professor

Bailey, of West Point, and others; and in partial proof that all the organisms entering into its composition are dead, the statement was made that "there are never spines on the globigerinæ from the bottom, even in the shallowest water." This is a mistake, as the spinous globigerinæ were quite abundant in the soundings from the Gulf of Campeche made during the summer of 1874, during the cruise of the United States steamship *Fortune*, from depths of between 64 and 210 fathoms.

ETHNOLOGY.

Our summary of progress in *Anthropology* and *Ethnology* will embrace:

1. An account of prehistoric researches in various parts of the world.
2. A record of investigations among living tribes of men.
3. A synopsis of discussions upon general and special problems.
4. A report of improved apparatus of research; of expeditions and instructions to observers; of anthropological societies and sections of general societies, and their published Proceedings; of museums and notable private collections; of periodicals, wholly or in part devoted to anthropology; and of the bibliography of the subject since the publication of our last volume.

I. PREHISTORIC RESEARCHES.

America.—The Alaska Commercial Company has presented to the National Museum eight mummies from the cave of Kagamil, Aleutian Islands. They resemble those from Peru, being doubled up and wrapped in the finest furs and grass matting.

Alphonse L. Pinart publishes an account of his exploration of the cave of Aknanh, Island of Ounga.

Le Père Pétitot, in a long communication to the Paris Geographical Society, describes the stone and bone implements found in the Mackenzie River district.

Some of the most extensive and successful researches ever made in American archæology are being conducted by Mr. Paul Schumacher, under the auspices of the Smithsonian Institution, on the west coast of the United States from Oregon to the Santa Barbara Islands. Hundreds of skulls have been exhumed, and the amount of mortars, pestles, stone implements of every sort, pottery, burial deposits, etc., is simply incredible. A partial report of his labors will be found in the Smithsonian Report for 1874. The finest specimens of his collection will be exhibited at the Centennial. Further reports on California will be found in the paper of A. S. Hudson, M.D., "On Shell-mounds in Oakland, California" (Proc. Cal. Acad., 1874), and that of Mr. L. G. Yates, on "Aboriginal Mounds in California" (Am. Assoc., 1875). The researches of Stephen Powers in Northern California, and of Rev. Stephen Bowers in Santa Barbara, are also to be noticed.

The government surveyors of the Great Interior Basin have been as fortunate as usual in discovering relics of ancient populations.

Messrs. Holmes and Jackson have examined a series of rock-shelter dwellings, towers, burial-places, etc., and have recovered a great number of inscriptions from the face of the cliffs in Southwestern Colorado and Northeastern Arizona, on the River San Juan and its tributaries. The most interesting of their discoveries in 1874 are described in Bancroft ("Native Races," Vol. IV., Chap. XI.). Their last summer's finds are graphically detailed in the *N. Y. Herald* letters.

Professor R. J. Farquharson read a paper before the American Association at Detroit on "Recent Mound Explorations at Davenport, Iowa." Mr. Henry Gilman gave an account of the ancient men of the great lakes, with especial reference to flattened tibiæ. In the Smithsonian Report for 1875 the same author will describe skull perforations from the same district, of which he has observed about twenty examples. The following communications were also made to the Detroit meeting: "On Mound Explorations in Kent County, Michigan," by Professor E. A. Strong and W. C. Coffinberry; "On Archæology in Wyoming," by F. B. Comstock; "On Ancient Structures of New Mexico," by E. D. Cope; "On Indian Mounds and Shell-heaps near Pensacola, Florida," by Dr. George Sternberg.

Dr. C. Schmidt read before the German Association at Munich a memoir on American mounds compared with remains of old mounds in Southern Germany. Mr. Joseph Wilcox describes in the Proceedings of the Academy of Natural Sciences of Philadelphia an ancient burial custom in Tennessee.

The State Archæological Association of Indiana held a meeting on September 29th and 30th, to take measures for preserving the monuments of the state. Other states of the Mississippi Valley are engaged in the same laudable work.

Dr. N. Joly has an article in *La Nature* (January 23, 1875) on "L'Homme Primitif Américain."

In *Revista de Antropologia*, Madrid, February and May, 1875, is an article entitled "De las Armas offensivas y defensivas de los Primitivos Americanos."

Mr. Hyde Clarke has just published, through Trübner & Co., in pamphlet form, his article in the *Journal of the Anthropological Institute* entitled "Researches in Prehistoric and Protohistoric Comparative Philology, Mythology, and Archæology in Connection with the Origin of Culture in America, and the Accad or Sumerian Families." The author attempts to utilize the latest investigations of cuneiform inscriptions in unveiling the mysteries of American colonization.

The eighth Annual Report of the Peabody Museum contains an account of the Swallow Collection, the Collection of Professor Wyman in Florida, and reports of smaller North American donations.

The "Congrés International des Américanistes" was held at Nancy from July 19th to 22d. The programme was as follows:

First Meeting.—History of Ancient America, and ante-Columbian relations with the Old World. President, M. Torres Caicedo, San Salvador.

Second Meeting.—Ethnology. President, Professor Hynes, Boston.

Third Meeting.—Language. President, Waldemar Schmidt, Copenhagen.

Fourth Meeting.—Archæology. President, Fr. von Hellwald.

The following gentlemen presented papers:

M. Gravier. The Dighton Rock inscription.

M. Foucheux. The Relation of the Buddhists with America at the commencement of our era.

M. Lucien Adam. The legend of Hoei-Chin, and the claims of Mexico to be the Fou-Sang of the voyagers.

The legends of the lost Atlantis, of Phœnician voyagers to our shores, and of Phœnician inscriptions, met with little favor. The opinion of M. Dally, that in studying American primitive history the purest scientific processes should be employed, met with general approval.

M. le Baron de Bretton, delegate of the King of Denmark, presented an important paper on the discoveries of the Northmen.

In the second meeting, the following gentlemen participated:

Dr. Paul Broca. On the deformed skulls of the Chibchas and other tribes.

M. L. Petitot. On the Southern origin of the Esquimaux.

M. Mader de Montjau. On the indigenes of Hayti.

M. Jules Ballet, of Guadaloupe. On the Caribs of the Antilles.

In the third meeting, papers were read by:

M. Pacheco Zigarro, of Cuzco. On the Quichua.

M. Leon de Rosny. On the systems of deciphering the Maya.

M. Julien Adam, for M. Julien Vinson. On the pretended analogy between the New World tongues and the Basque language.

In the fourth meeting the following gentlemen took part:

M. Oscar Comettant. Music in America before Columbus. "The Peruvian flute is sad, timid, and prophetic; and, after having presided over the magnificent fêtes of the Incas, serves to console their descendants in degradation and slavery."

M. Waldemar Schmidt. On sketching and other art manifestations among native Greenlanders.

The executor of the will of Mr. George Latimer has sent from Porto Rico to the Smithsonian Institution the magnificent prehistoric collection of that gentleman, embracing 36 sacrificial yokes (?), a large number of mammiform stones of various patterns, a beautiful collection of celts, besides a variety of other materials.

In *Scribner's Monthly* for August is an illustrated article on the "Stone Age of the Antilles."

Mr. Herbert Spencer's "Descriptive Sociology," Div. II., Pt. I., B, is devoted to Mexicans, Central Americans, Chibchas, and Peruvians.

Vol. I. of Pinart's "Bibliothèque de Linguistique et d'Ethnographie Américaines," is devoted to the "Lingua Chiapaneca."

Lopez Borregnero has published in Madrid this year his work entitled "Los Indios Caribes, Memorias Interessantes de Venezuela.'

Mr. Hutchinson continues his interesting researches among Peruvian antiquities. He objects to having them all ascribed to the Incas. He agrees with Mr. Baldwin that the original South Americans were the oldest people on the continent, and that "the mythical cradle of the Incas will be sought in the National Library at Madrid, instead of in the Lake of Titicaca, to which latter place it is assigned by the Hackluyt Society."

In the *Revue d'Anthropologie*, No. 1, 1875, M. Ber makes a communication on the prehistoric populations of Ancon, Peru, with an appendix by M. Topinard. Professor Bastian is now traveling in Peru and Ecuador, examining their antiquities.

Dr. Reiss, of Riobamba, Ecuador, sent to the German Anthropological Society, in 1874, some interesting remains of the times of the Incas. Professor Seebach at the same meeting gave an ethnographical scheme of the Central American tribes.

Professor Hartt, in his treatise on pottery, promises an extended work on Brazilian antiquities.

Francesco P. Moreno has published in Buenos Ayres, "Noticias sobre antiquidades de los Indios del tempo antérior á la Conquista de Buenos Ayres."

The most interesting prehistoric find from South America is the skeleton of a fœtus from Peru, presented to the museum of the Laboratory of Anthropology of Paris by Dr. Bourrie. Dr. Paul Broca has made a thorough examination of this specimen with reference to the pretended "os de l'Inca," or the uniform occurrence of a supernumerary bone in this race, similar to the intraparietal of some mammals. He concludes, "It is certain that the great majority of Peruvian skulls do not possess this intraparietal bone, but the phenomenon occurs often enough to render it probable that it occurs more frequently among the Peruvians than in any other race."

The whole subject of North American Archæology is reviewed in the fourth volume of Bancroft's "Native Races," embracing among other matters the latest researches of

Messrs. Holmes and Jackson among the rock-shelter structures, stone towers, etc., of Arizona and New Mexico.

Europe.—In the Belfast volume of the British Association (p. 116) is a most interesting abstract of Sir William Wilde's address before the Anthropological Department, on the subject of the early races who peopled Ireland in consecutive order, their remains still existing, and an inquiry as to what vestiges of these different waves of population remain to the present hour.

In discussing the names of the rivers and peoples in Ireland, Hyde Clarke, before the same meeting, called attention to the similarity of many of them with those of the civilized tribes of North America. This was not due to the Phœnician, but to the much earlier period of civilization called the Sumir and the Accad of Babylonia, when the world was of one official speech, and great monumental cities were raised by people speaking allied languages in Southern Europe, Asia Minor, Babylon, India, China, Peru, and Mexico.

Before the British Association this year the following papers on European Archæology were read:

Canon Rawlinson, "On the Ethnography of the Cymbri." The authority of Cæsar and Tacitus in favor of the Germanic origin of this ancient race was set aside for the belief in their affinity with the Celts. This elicited from Mr. Freeman a warm eulogy on the historians in question. Dr. Beddoe and the Rev. J. Earle supported the paper.

Professor Rolleston, "On the Long Barrow Period," which he divides into three epochs. In the earliest, the dead were buried in chambers or galleries so constructed as to admit of successive interments. In the next period the dead were buried unburned in cists. In the third, cremation was practiced.

W. Mortimer, "On the Crania of the Round Barrows of the Yorkshire Wolds."

W. Pengelly, F.R.S., "On the excavation of Kent's Cave," and Mr. R. H. Tiddeman on the "Victoria Cave." The president of the section, Dr. T. Wright, commenting on the reports, was of the opinion that no direct evidence had been found that man existed in the British Isles previously to the glacial period. Mr. Pengelly will deliver a course of lectures, the coming season, before the Glasgow Lecture Association, on Kent's Cavern—its testimony to the antiquity of man.

Mr. Brooke Pennington (Dec. 8th, 1874) read a paper before the Anthropological Institute on the tumuli and stone circles near Castleton, in Derbyshire. He gave a full account of the explorations of the barrow of Eldon Hill, forty-nine feet in diameter, containing remains of man, horse, rat, and pieces of wrought antler. The Rev. S. Magens Mello also spoke of a bone-cave in Cresswell Crags, on the eastern border of Derbyshire.

In France the greatest activity prevails with reference to researches in definite localities, and concerning the strata of population successively inhabiting the different departments. In addition to the *Bulletin de la Société d'Anthropologie*, two able periodicals, *Revue d'Anthropologie*, and *Matériaux pour l'Histoire primitive et naturelle de l'Homme*, are devoted entirely to anthropological investigations.

Before the French Association, Dr. Lagneau read a long and scholarly memoir on the ethnogeny of the populations of the northwest of France, passing in review the different peoples concerned in the ancient and present occupation of the region between the sea, the Saone, and the Loire. In prehistoric times, some dolichocephalic skulls, and two kinds of brachycephalic skulls—the one kind small, the other large and voluminous—assert the existence of at least three distinct races. The author cited both classic authorities and modern researches to establish his conclusions; and from the discussion awakened we conclude this to be one of the most important papers read.

M. Chantre also read a report on excavations made by the Archæological Society of Charente. M. Philip Salmon gave a description of his discoveries at Grand Noue, commune of Vinneuf (Yonné). M. de Baye reported having extracted from the grottoes of Baye (Marne) 54 skulls: 28 of men, 24 of women, and 2 of children.

Parts XVI. and XVII. of "Reliquiæ Aquitanicæ" have appeared, the former containing:

Chapter XXIII. Observations on the birds whose bones have been found in the caves of the southwest of France, by Alphonse Milne-Edwards.

Chapter XXIV. Notes on objects of stone from the caves of Les Eyzies, valley of Vezere, Perigord, by Professor T. Rupert Jones.

Chapter XXV. (extending into Part XVII.). Fossil man from La Madelaine and Laugerie Basse, by E. T. Hamy:

"The human bones from La Madelaine, Laugerie Basse, Bruniquel, etc., have recently been compared with those of the rock shelter of Cro-Magnon, and, thanks to the exaggerated ethnic characters of the latter, a number of peculiarities of the second order, which at first escaped notice, have been recognized and appreciated. We have been able up to a certain point to classify the characters, the degree of the fixity of which has been brought out by all these comparisons, consequently to determine which are the constant features of a race, and which are individual variation, and the amount of the latter, and finally, with the aid of this determination, to commence the study of the extension of the ethnic group in space and time." Part XVII., containing the closing chapters and full indexes, finishes up the work.

The origin and spread of the Basques is eliciting a great deal of discussion in France and the rest of Europe. Dr. Paul Broca, in *Revue d'Anthropologie*, No. 1, 1875, has a long and interesting article on the subject. In the *Journal* of the Anthropological Institute, the Rev. Wentworth Webster reviews at length the article of Boyd Dawkins in the *Fortnightly* of September, 1874, on the same subject.

At the Geographical Exposition, Paris, a prehistoric chart of France was exhibited by M. Mortillet. The same author has completed a scheme of French early history.

The *Paleolithic Age* he divides into four epochs:

St. Acheul. (Almond-shaped flaked axe.) The oldest.

Moustier. (Flint arrow-heads and scrapers, bilateral flake.)

Solutré. (Bay-leaf shaped arrow-head, bilateral chipping.)

Madelaine. (Barbed bone arrow-heads and flint knives.)

The *Neolithic Age* has one epoch:

Robenhausen. (Polished stone axes, flint arrow-heads, serrate chipping.)

The *Bronze Age* has two epochs:

Morgien. (First appearance of bronze.)

Larnaudien. (Objects hammered out, greater variety and finish.)

The *Iron Age, Protohistoric Era*, has two periods — the *Tumulus* and the *Gallic*.

The *Tumulus Period* has one epoch:

Hallstattien. (First appearance of iron.)

The *Gallic Period* is called

Marnien: epoch of the Marne, Helvetian epoch, third Lacustrian epoch. (Appearance of money.)

The *Iron Age, Historic Era*, has two periods — the *Roman* and the *Merovingian*.

The *Roman Period* has two epochs:

Lugdunien. (Roman money and industry prevailing.)

Champdolien. (Decadence of art and industry.)

The *Merovingian Period* is called

Wabenien: epoch of Waben, Frank or Burgundian epoch, Helveto-Burgundian epoch, Germanic epoch. (Roman industry replaced by forms entirely new.) — "Matériaux," 1875, Aug., p. 373; and "Tableau Arch. de la Gaule," Paris, E. Leroux.

A communication made by Dr. Prunières, of Marvejols, before the meeting of the French Association for the Advancement of Science at Lille, treated of the curious artificial perforations common among the neolithic skulls of the Lozère. These perforations vary in the pieces exhibited from an inch to an inch and a quarter in diameter. Near the perforated skulls were found rings of cranial bone, which seemed to be designed as amulets. They were evidently worked with flint tools. The men of the polished stone age practiced trepanning; for if some of the skulls appear to have been perforated after death, others were treated during life, and the patients had lived for years afterward. One skull presented three perforations, made near each other upon a line fore and aft. There is no distinction of age, the excisions occurring upon infants as well as upon adults. The motive of this strange custom was either medical or superstitious. They probably attributed disease to supernatural agencies. The evil spirit escaped through the opening made by the sorcerer, who wrapped the operation in a shroud of mystery by preserving the detached piece as a precious relic. From the appearance of these facts reported by the learned archæologist of Lozère, he said that a new light had been shed upon the intellectual state of man in the polished stone age.

It explained his religious conceptions, and confirmed the discovery of the figure of a goddess in the caverns of Baye (Marne). M. Broca remarks that perforated skulls were found also at the last-named station. Among the skulls dug up by General Faidherbe were found two in the same condition. Dr. Chil, from the Canary Islands, said that perforated skulls had been found in the ancient burial-places of his country.

Attention was also called to an example from the grotto of Lorde, upon which M. Hamy and M. Chaplain-Duparc gave some interesting details. A similarly perforated or trepanned skull was found by Mr. E. G. Squier among some ancient Peruvian crania collected by him.—*Bull. Soc. d'Anthro.*, 1874, 2 fasc., pp. 185, 205, and 1875, p. 542, 555; *Comptes Rendus*, 1874, LXXIX.; *Pop. Sci. Monthly*, Sept., 1875, p. 607.

Before the French Association, 1875, M. Chauvet reported the same phenomenon in the tumuli of Charente. A discussion by Dr. Broca and others ensued. See also in Part II. of this paper under *Sanson*.

M. Choquet, in his excavations near Montereau (Seine et Marne), has discovered, in connection with pottery, vases, and polished flint hatchets, forty-four distal ends of humeri, which have the olecranian fosse piercing the bone similarly to those mentioned by Mr. Henry Gilman in the Michigan mounds.

M. E. Baudrimont has discovered in the dolmen of Font-Real (Aveyron) a fragment of the lower part of a tibia exhibiting an exostosis produced by a flint arrow-head driven in, not by the point, but by the barbs, and in such a position that the projector was either below or pursuing the subject. The difficulty of conceiving how an arrow could have been shot into such a position inclines M. Baudrimont to think that we have here an example of primitive surgery.

The subject of Swedish Archæology is described in the work of Oscar Montelius, entitled "Sur les tombeaux et la topographie de la Suede pendant l'age de la pierre."

C. Engelhardt ("Matériaux," 1875, liv. 1, p. 68) gives an account of a tumulus excavated by him in Laland, Denmark. In the same volume (page 350) is a *résumé* of archæological work done in Denmark since 1869.

We have also received the report of the Museum at Copenhagen, by Waldemar Schmidt, containing, among other matters, an illustrated account of some Porto Rico stone implements.

A new pile-dwelling was lately discovered at the Swiss hamlet of Vingelz, not far from Biel, where, at a depth of only about three or four feet below the surface, a platform was found resting upon piles, and composed of beams nearly a foot thick.

The most interesting prehistoric Swiss discovery is that of Dr. Scheuermann, of Basle, who called the attention of Professor Rutimeyer to the fact that, while observing the impression of plants in the lignite (Schieferkohle), he noticed a number of pointed sticks resembling in appearance the surrounding coal. These Professor Rutimeyer thought to be of the species *Abies excelsa*, and certainly showing evidence of human workmanship. He moreover regarded them as contemporaneous with the coal. This coal is not only overlaid with glacial drift, but at least in some places (Metzikon, etc.) its substratum is of an erratic nature. If the Professor's conclusions are correct, we have here evidences of human work contemporaneous with *Elephas antiquus*, *Rhinoceros murkii*, cave bear, and aurochs in an interglacial period.

The annual meeting of the German Anthropological Society was held at Munich from the 9th to the 11th of August. The most flattering reports were received with reference to the prehistoric charts of Germany, which when finished will enable us to draw up for that country a scheme of history similar to M. Mortillet's archæologic charts of Gaul. Professor Schaafhausen presented a report upon the expenses incurred in excavating at Klusenstein, the cave of Hönnethal, and Martin's cave near Letmath. Professor Virchow spoke of some peculiar forms of skulls from the islands of the Zuyder Zee, and of the exhaustive work of J. Wilhelm Sprengel on the skulls of the Neanderthal type. (Brunswick, Vieweg & Son, 1875.)

In the report of the association for 1874 is a paper by Herr Virchow on the areas of brachycephalic skulls in prehistoric and historic times in Germany. Dr. Much, at Munich, gave an account of archæological researches in 1874 among the old German habitations and forts in Lower

Austria, especially on the Donau and the March.—*Mittheil. der Anth. Ges. in Wien*, 1875, Nos. 2, 3, 6, 7.

Herr Eckers made a report on researches into the remains of the Celts in South Germany. "Philology and archæology testify to the presence of the Celts, but Celtic skulls are unknown among us. Cemeteries containing dolichocephalic Germans exist every where, while in the tumuli graves, especially in Schwarzwald, the brachycephalic skull prevails. Have the Germans in their immigration into their present abodes found a people whom they partly destroyed, but from whom the tumuli graves proceed?" The discussion of the Celt question was taken up by Virchow, Kollman, Schaafhausen, Desor, Lindenschmidt, Mehlis, Marggraf, and others. Virchow also made a communication on the dikes of defense in Posen.

Major Wurdinger gave a brief account of the prehistoric finds in Bavaria. "The Stone, Bronze, and Iron Ages are not sharply divided here. Near Rosering a stone celt was found with an iron sword. In a mound on the Salzach a stone hammer was found with bronze rings of the later Roman period. In the palafittes of Starnburger Lake, rude and polished stone implements predominate over bone and horn."

The following interesting papers have been read before the Anthropological Society of Vienna:

"Prehistoric Discoveries in Lower Austria in 1874," by Heinrich Graf Wurmbrand.

"Results of Palafitte Researches," by the same.

"On Microcephaly," by Dr. A. Zuckerkandl.

"Prehistoric Objects from Schüttenhofen (Bohemia)," by J. Woldrich.

"A Macrocephal Turkish Skull," by A. Weisbach.

"The Bone-cave of Thayngen, near Schaffhausen," by L. Rutimeyer (see *Annual Record*, 1874, p. cxxi.). Professor Merk has published an account of this, a translation of which by J. E. Lee is issued by Longmans & Co. The next annual meeting will be held at Jena.

A shell heap has been discovered near Athens, composed almost entirely of a species of murex, and of others furnishing coloring matter. It is therefore concluded that this is the site of an ancient manufactory of the celebrated Tyrian purple.

The *National Quarterly Review*, 1875, pt. iv., has an article on Prehistoric Greece.

The whole subject of the European Stone Age is comprehensively and ably presented by Dr. Charles Rau, of New York, in *Harper's Magazine* from April to September, 1875.

Africa.—Dr. Chil y Naranjo read a note before the French Association describing the superstitious practices of the ancient Canariens.

There is an account of old Egyptian culture in the light of modern researches in *Ausland* of March 9th, et seq., with profuse references to authorities.

Hyde Clarke read a paper before the British Association at Bristol on prehistoric culture in India and Africa.

Asia.—F. von Hellwald treats of the voyages of the Phœnicians in *Ausland*, January 4, 1875, et seq.

The surveys of the Palestine Exploration Fund have been pushed forward this season, and many sites have been identified. The party was attacked during the summer, and some of them wounded, including Lieutenant Conder.

The American Palestine Exploration Society have pushed their work forward on the east of the Jordan.

George Smith has again visited the Mesopotamian valley. He has written two volumes of the "Ancient History from the Monuments," and he has been able to recover from the fragments in the British Museum the legend of the building of the tower of Babel.

At the meeting of the Anthropological Institute, November 24, 1874, Mr. C. Colesworth read a communication describing the ruined towers of Palmyra, containing skulls and other human remains, which were examined and reported on by Professor Busk.

The volume of Monier Williams, entitled "Indian Wisdom" (London, 1875, 8vo), is the best work on the literature, religion, etc., of the ancient Hindoos for the general reader.

General Cunningham has issued from Calcutta his report of the Archæological Survey of India. James Burgess has also published (London, 1875, 4to) an Archæological Survey of Western India.

Polynesia.—Herbert Spencer's Descriptive Sociology (No.

3, Part I, A, Division I.) is devoted entirely to Types of the Lowest Races, Negrito Races, and Malayo-Polynesian Races.

II. ETHNOLOGY OF EXTANT RACES.

America.—M. Alphonse L. Pinart has published in Paris this year "Ethnologie de la Cote Nord Ouest de l'Amérique," and other pamphlets on the same subject. M. l'Abbé Petitot has a long and carefully prepared article (*Bull. Soc. de Geog.*, July, Aug., Sept.) on the geography of the Athabasca-Mackenzie, in which he gives an exhaustive account of the people, dividing them into Esquimaux, Algonquins, and Déné-Dindjies; the last named—commonly called Athabascans, Chippewyans, or Tinnehs—are a large family of Indians inhabiting Western Alaska, Hudson Bay Territory, British Columbia, etc., back from the sea. The author also at the Congrés des Américanistes gave a most interesting account of his residence among the people as a missionary. He will publish, through E. Leroux, Paris, a "Dictionnaire de la Langue Déné-Dindjie (Montagnais, Peaux de Lièvres, Loucheux)."

Mr. James G. Swan, under the auspices of the Smithsonian Institution and the Indian Bureau, will make an interesting collection from the northwest coast to be exhibited at the Centennial. The Rev. M. Eells has sent to the Smithsonian Institution a manuscript of 164 pages, minutely describing the Twamish Indians of Hood's Canal.

In the Proceedings of the California Academy for 1874, Mr. Stephen Powers has two papers, one on the California aborigines (392), another on aboriginal botany (373). In the same volume is an illustrated article on the "mesh knot" of the Port Simpson Indians, by George Davidson.

The Smithsonian Report for 1874 contains an interesting account of the burial of a squaw in San Bernardino, Cal., by W. M. King.

General H. B. Carrington gave an account before the British Association of the Indians of Dakota.

All lovers of American ethnology will hear with pleasure of Mr. Shea's continuation of American Linguistics. The new series will commence with "A Grammar and Dictionary of the Language of the Hidatsa (Gros Ventres)," by Washington Matthews, M.D., U.S.A.

Major J. W. Powell, in his report of the Explorations of the Colorado River of the West, gives some notes and illustrations of the ethnology of that district. His long acquaintance with the people, and their perfect confidence in him, make him one of the most reliable historians of their culture. He has a large collection of photographs of their principal personages, of men, women, and children, singly and in groups, engaged in their characteristic occupations. He has also contributed to the National Museum a fine collection of vessels, clothing, ornaments, implements, weapons, gambling apparatus, and art-work, many of which will grace the Centennial. The whole subject of aboriginal life within the United States will be fully represented on that occasion. A pamphlet of instructions has been sent to Indian agents and others, and materials are already coming in from every quarter, and of the most interesting character. It is also proposed to display the living tribes by a family of four or five individuals in a special reservation in the Philadelphia Park, with their own outfit of clothing, dwelling, implements, etc.

The massive work of Hubert Howe Bancroft on the "Native Races of the Pacific States," whose first volume was merely noticed last year, is now completed. The hearty thanks of all students of American ethnology are due to the author for the zeal and patience with which he has prosecuted his labor. We have no space for a summary of the contents of a work which in order to be appreciated must not only be read but carefully studied. The 160 pages of index is itself a remarkable production.

Dr. J. H. Trumbull delivered a long and scrupulously prepared address upon the "American Language" before the American Philological Association, Newport, July 13, 1875.

Das Ausland (November 9, 1874) has a carefully written article on the linguistic researches of Dr. Hermann Berendt in Central America.

Mr. Henry Hague has recently sent to the National Museum the instruments of a full band of music of the Tactic Indians, among them the marimba, so graphically described by Arthur Morelet.

Franz Keller, in his accounts of his tour on the Amazon and Madeira Rivers, describes the habit of eating clay practiced among the natives of the forests in their border. They are so addicted to it that the prospect of a speedy and miserable death does not deter them. The negroes who work the plantations are compelled to wear iron masks, and are allowed to take them off only under the strictest surveillance. Beasts (excepting the jaguar) and birds are affected with a similar appetite. Hunters take advantage of the fact by hiding on moonlight nights near one of these clay beds, called barrieros, to which the deer and swine come to eat earth, and the jaguar to secure his prey.

Charles Frederick Hartt, A.M., chief of the Brazilian geological survey, has published at Rio Janeiro "Amazonian Tortoise Myths;" among others, the old fable of the tortoise and the hare appears as the tortoise and the deer.

In *Bullet. Soc. d'Anthropologie* (Paris, 1874, 2°, p. 222) Abbé Durand has a paper on the Sambagues of Brazil. In the same number (p. 182) is a paper on the Apeicas.

The Hackluyt Society has published "The Captivity of Hans Stade, of Hesse, A.D. 1547–1555, among the wild tribes of Eastern Brazil," translated by Albert Fortal, Esq., of Rio Janeiro, and annotated by Richard F. Burton.

Mr. Robert Ellis is the author of a work entitled "Peruvia Scythica," the Quichua language of Peru, its derivation from Central Asia, with the American languages in general, and with the Turanian languages of the Old World, including the Basque, the Lycian, and the pre-Aryan language of Etruria (London, 1875, 8vo, 219 pp.).

Two individuals, Bartola and Maximo, who have been exhibited in Europe and America since 1850 under the name of Aztecs, having been presented recently to the Society of Anthropology, Paris, by M. Topinard, a most animated and exhaustive discussion ensued upon the descriptions which have been given of them by Owen and others, and of the subject of Microcephaly in general.—*Bull.*, 1875, p. 36.

Europe.—Dr. Beddoe, in the report of the Belfast Meeting of the British Association, has an abstract of his paper on the modern ethnological migrations in the British Isles.

Attention is again called to M. Lagneau's paper before the French Association, mentioned under a previous heading.

Herr Schaafhausen read before the German Anthropological Society at Munich a paper on the early migrations of the Lapps, and Virchow also gave a *résumé* of the Lapp controversy. M. Venioukoff's essay, to be hereafter mentioned, treats of the same subject.

At the same meeting Virchow made a report of investigations concerning the color of the skin, hair, and eyes of the children in public schools. Scholars examined, 760,000; 66⅔ per cent. light-eyed, 33⅓ per cent. dark-eyed; 54 per cent. blonde-haired, 41 per cent. brown-haired, 5 per cent. black-haired; 85 per cent. light-skinned, 15 per cent. brunettes.

In the Göttingen section of the German Anthropological Society, Professor Benfey discussed the language and customs of the Gypsies. Dr. Kopernicki reports his researches on Bulgarian skulls in *Archiv* and *Journal* of the Anthropological Institute (Dec. 11, 1874).

Hyde Clarke read a paper on the Himalayan origin of the Magyar and Finn languages; and Dr. Sauerwein before the German Anthropological Association one on the Northern Hungarian peoples.

Africa.—At the International Geographical Congress, M. Bourgeot attempted to show the affinity between the North Africans and the Caribs. At the same meeting Conto Murisculchi-Erizzo presented some locks of Akka hair. The work of Dr. Gerhard Rohlfs, entitled "Quer durch Afrika," holds a prominent place among the ethnological works of the year.

M. Bastian made before the German Association at Munich a very interesting report of his journey to West Africa. See also "Die deutsche Expedition an der Loango-Küste," etc. (Jena, Vol. I., 1874; Vol. II., 1875), by the same author.

M. Achille Haffray sends to the *Bulletin de la Société de Geographie* (September, 1875) an account of his "Voyage en Abyssinie a Zanzibar et au pays des Ouanika." Dr. Berenger Feraud publishes in *Revue d'Anthropologie* (I., 1875) his study of the Peuls of Senegambia.

The Hottentots and peoples of South Africa are discussed in a communication made by A. Merensky before the Berlin Anthropological Society (*Ausland*, Nos. 34 and 35, 1875). Before the same meeting Herrn Bartells and Fritsch exhibited a Basuto boy from the Transvaal Republic. The geographical expeditions of Stanley and Cameron promise a rich harvest of ethnological information.

Asia.—Dr. Halevy communicates to *Ausland* (November 16, 1874) an account of his journey through the Redschran; and Dr. Paul Langerhaus reported to the German Anthropological Society (1874) a trip among the Syrian Bedouins. He secured a number of photographs and skull measurements from the noble tribes of Adwan, Abbad, and Abudis, differing so materially from the Syrian Fellahin.

Before the British Association, Dr. Leitner described an ethnological and linguistic tour of discovery through Dardistan, the chief result being to establish the existence of languages contemporary with the Sanskrit.

In the report of the Belfast Meeting of the British Association (1874) is an abstract of a paper by Fred. Drew, F.G.S., on the distribution of the races of man inhabiting the Jummir and Cashmere districts.

Sir Walter Elliott read a communication before the anthropological section at Bristol on the localities of the races forming the present populations of India. The Koragars, a leaf-wearing tribe on the west coast of India, were described by J. Walhouse before the Anthropological Institute, London.

In a very interesting communication upon the Negritos of India, before the International Geographical Congress, Dr. Hamy showed the presence of this race of oceanic Negroes of short stature on the Gangetic peninsula. With great erudition he proved that the Negritos ought to occupy a large space of this territory, and that they have been little by little dispersed and almost annihilated by their invaders. M. Quatrefages followed on the same theme, drawing attention to the isolated groups of Negritos as distinguished from the compact Papuans, pointing to the probability of their having been the ancient inhabitants, and to their dispersion by other races.

Herr Jagor reported to the German Anthropological Society his ethnological tour in India, in which he had been liberally patronized by the Prussian government. A table of the races of Northern India is given by Louis Rousselet.

Mr. Bertram Hartshorne read before the British Association at Bristol a paper of the most thrilling anthropological interest on the Weddas of Ceylon.

The Andamanese were the theme of a communication to the Anthropological Institute, on January 12, 1875, by Mr. G. E. Dobson.

At the International Geographical Congress in Paris, two long and able papers were read, the one by M. Venioukoff upon the races of Asiatic Russia, the other by M. de Hujfalvy upon the migrations of the Ouralo-Altaic races. Both elicited considerable discussion, and may be regarded as among the most able presented to the Congress. On motion of M. Hujfalvy, the name Turanian was abandoned for Ouralo-Altaic, as applied to non-Aryan races of Europe and the peoples of Northern Asia.

An account of the Ainos was given to the German Anthropological Society (1874) by Herr Pomoli, who considers them the probable aborigines of Japan, reaching back to the cave-bear period.

Arthur Conner described before the Royal Geographical Society his journey to the interior of Formosa (Proc., Aug., 1875). The account of the Japanese expedition to Formosa has been published at Yeddo in English.

At the meeting of the Anthropological Society of Göttingen (July 17, 1875), Dr. Von Ihering gave an account of teeth mutilations, especially in Southeastern Asia.

Oceanica.—Lieutenant Crespigny read a paper before the Anthropological Institute (*Journal*, July, 1875) on the Milanows of Borneo. The same people are described by M. Miklucho-Maklay.

Captain John C. Lawson (Anth. Inst., June 22, 1875) gives an account of the Papuans. Virchow made a report on Papuan skulls before the German Anthropological Society, 1874.

Australian ethnology is represented by the communication of Mr. John Forrest to the Anthropological Institute (June 22, 1875) on "the Natives of Central and Western Australia." Volume X. of the "Transactions and Proceedings of the Royal Society of Victoria" contains a paper by H. G. Pain on the Decay of Aboriginal Art in Australia and Polynesia.

Before the British Association, Bristol, Rev. Wyatt Gill gave an account of the Maories of New Zealand. "The Transactions and Proceedings of the New Zealand Institute, 1875," contains the following ethnological papers: The Mythology and Traditions of the Maoris in New Zealand; Notes on an Ancient Native Burial-place near the Moa-bone Point;

Notes on the Moa-hunter Encampment; On the Identity of the Moa-hunters with the Present Maori Race; On Maori Traditions; On the Discovery of a Cut Stump of a Tree giving Evidence of the Existence of Man in New Zealand at or before the Volcanic Era.

Dr. Barnard Davis contributed to the Dutch Academy of Sciences an exceedingly valuable paper relative to the Tasmanians. Their almost entire extinction within the last few years makes their history a subject of painful interest.

Dr. Rolleston, in his opening address before the Anthropological Department of Section D, British Association, spoke in congratulatory terms of the work of Dr. Carl Meinicke, "Die Inseln des Stillen Oceans" (Leipsic, 1875), and the article of the Rev. J. W. Whitmee in the February number of *The Contemporary Review* (1873) on the Ethnography of Polynesia.

Rev. Wyatt Gill read a paper before the British Association, Bristol, on the Traditions of the Hervey Islanders.

In *La Nature* (February 15, 1875) is an article by Dr. E. Hamy, entitled "Les Polynésiens et leur Extinction." He also read a paper before the Royal Geographical Society (October 21, 1875) on the results of his researches on the geographical distribution of the human race in East Melanesia. On the subject of extinction compared with ancient times, see Professor Rolleston's address before mentioned. The depopulation of Fiji by the measles is one of the latest disasters of this class.

The artificial perforation of the skull among the South Sea Islanders is the subject of an article in the *Bulletin de la Société d'Anthropologie* (1874, p. 494), by A. Sanson.

The *Journal* of the Anthropological Institute (July 5, 1875) gives an abstract of Edwin Reed's abbreviated translation of Dr. Philippi's work on Easter Island, published in Santiago in 1873.

No. 3 of Herbert Spencer's "Descriptive Sociology" is devoted to Types of Lowest Races, Negrito and Malayo-Polynesian Races.

III. DISCUSSIONS OF PROBLEMS.

Anthropology is so dependent and so widely related that the discussions which arise relative to it are almost innumerable. They comprehend the deduction of almost all sciences. We can only indicate a few of them, and refer the reader to those publications where he will find them more fully treated.

Origin of Man.—The greatest interest is springing up with reference to Microcephaly in its relation to the origin of our race. Dr. Samuel Pozzi (*Rev. d'Anth.*, II., 1875), following up the investigations of Marshall (*Phil. Trans.*, Vol. 154, XV., p. 501), of Bradley (*Jour. of Anat. and Phys.*, 2d Ser., Vol. VI., p. 65), of Broadbent (*id.*, III., p. 218), of Jensen (*Archiv für Anth.*, IV.), of Vogt (*Mém. de l'Inst.*, Geneva, XI.), of Schule (*Archiv*, 1872, p. 432), and of Aeby (*Archiv*, 1874), gives a summary of investigations, and his own conclusions on the subject. We have further discussions before the French Association this year, elicited by a microcephal boy presented to the meeting by Dr. Laennec on behalf of Dr. Petit, of the Asylum at Nantes. Dr. Paul Topinard (*Bull. Soc. d'Anth.*, 1875, p. 36) makes a communication on the two microcephals Maximo and Bartola. In the same publication (II., p. 164) we have a paper on "L'Étude du cerveau des microcephales." On the same subject we would mention Haeckel's "Anthropogenie," reviewed in *Ausland* (March 15, 1875).

In *Nature* (December 17, 1875) is a very interesting article by E. B. Tylor on the relation of race to species, in which are applied the dotted diagrams of Mr. Francis Galton.

Chronology. — On the chronology of anthropology we would draw attention to Herr Graf Wurmbrandt's speech on the chronology of prehistoric discoveries before the German Anthropological Society in 1874, followed by a lively discussion; to Professor Lauth's essays in *Correspondenz-Blatt der deutschen Gesellschaft für Anthropologie, etc.* (August, September, November, December, 1874), "On the Definition of the Boundaries of the Prehistoric;" to the treatise of P. Cazalis de Fondouce ("Matériaux," 11 and 12, 1874) on the hiatus between Paleolithic and Neolithic Times; of Jacob Messikommer (*Ausland*, April 12, 1875) on the Antiquity of Man; to the discussion (*Bull. Soc. d'Anth.*, 1875, II., p. 170) upon the concurrence of bronze and stone implements in the cemetery of Carandra; to the paper of Fraas (Ger. Anth. Soc., 1874) on the Tertiary Man (see also *Correspondenz-Blatt*, 1875, p. 16); to that of G. de Mortillet (*Rev. d'Anth.*, 1875, I.) on prehistoric study among the orthodox; to the letters of Schliermann from the museums of Leyden, Copenhagen, Stockholm, Lubeck, Berlin, etc., in *Academy*, Nos. 171, 173, 174, 176, 179, 180; and to the work of James C. Southall on the "Recent Origin of Man."

Physical Anthropology.—Professor Rolleston, in his opening address before the Anthropological Department of the British Association, discussed the merits of Craniography in deciding the question of race.

On the subject of Macrobians, the article of Sir Duncan Gibb (*Journ. Anth. Inst.*, 1875, p. 804) is to be consulted.

The work of M. Quatrefages on the "Fossil Races of Men" is reviewed in the following publications: *Comptes Rendus*, January 11, 1875; *Ausland*, March 15, 1875; and *Revue Scientifique*, January 23, 1875.

Psychical Anthropology.—On this subject we would draw attention to Herbert Spencer on the Comparative Psychology of Man (Anth. Inst., June 22); C. Staniland Wake on the Origin of the Moral Idea (Brit. Ass. Rep., 1874, p. 158); and to Dr. Redner on the Psychological Discussion of Memory (*Munich Anth. Soc.*, Feb. 26, 1875).

Environment.—M. Elisée Reclus's great work, "La Terre et les Hommes," is appearing in monthly parts. This learned production will give the connections of geographical environment with the races of men who have inhabited the different parts of the earth.

Professor Marsh has brought out a new edition of his "Man and Nature."

A very interesting series of papers in *Ausland* (Jan. 4 to Feb. 1) is devoted to the contribution of plants and animals to Shemitic culture.

General.—The paper of W. D. Mackintosh on Anthropology, Sociology, and Nationality, before the British Association, and that of L. H. Morgan, before the American Association, on the Progress of Culture, are worthy of study.

Culture.—M. Pietrement, reviewing the treatise of M. Sanson, agrees with him that the bones found in great abundance at Solutré are the remains of horses killed in the chase. In this view he opposes M. Toussaint, who holds that the horse was domesticated, and slaughtered for food and in sacrifice.

J. S. Phéné, before the British Association, read a paper on the Age of Colossi, etc., with reference to America; and in "Matériaux" (1875, p. 394) is an article from Frederick VII. of Denmark on the methods employed in constructing the so-called "Halls of Giants," or dolmens.

Before the British Association, August 27, Mr. C. O. Groom Napier read a paper on the "Localities whence tin and gold were found." P. de Cessac is the author of a work, "L'Ambre en France aux temps prehistoriques." F. W. Unger (Göttingen, *Proc. Anth. Soc.*, Pt. I.) has a paper on the origin and working of bronze in Europe. G. de Mortillet read one (Fr. Assoc., 1874) on the introduction of the working of bronze in the West ("Matériaux," p. 459). M. A. Bertrand (*Bull. Soc. d'Anth.*) read one on the Oriental origin of the working of copper, tin, silver, iron, lead, etc. Wibel (Germ. Anth. Soc., 1874) read an essay on the chemical analysis of bronze.

Professor Drechsler made a communication on the beginning of agriculture, before the Anthropological Society of Göttingen.

"Matériaux" (February and March, 1875) has reproduced some interesting old papers on "thunder-stones."

Professor Hartt has published at Rio Janeiro "Notes on the Manufactory of Pottery among Savage Races," with references to authorities. Perhaps the very best production on the subject.

Colonel A. Lane Fox favors us with the Third Part of his Catalogue on Early Modes of Navigation, tracing the development of ship-forms. On the same subject attention is called to "History of Modern Shipping and Ancient Commerce," by W. S. C. Lindsay.

Professor Hartt has an article in the January Number of *Popular Science Monthly* on the "Growth of the Idea of Ornament."

On the subject of language, we call especial attention to E. de Chossat on the classification of the Babylonian and Ninevite cuneiform characters; to Hyde Clarke (Brit. Ass., 1875) on a Community of Aboriginal Names of Weapons in Prehistoric Times; to Dr. A.W. Bikkers on the Anthropological Aspect of Linguistic Metaphor; to Professor Whitney on the Life and Growth of Language; and to Dr. Hermann Brunnhofer (*Ausland*, 1875, No. 31, p. 611) on the Voices of Animals in Primitive Human Speech.

On domestic culture the following references are valuable: Anfänge der Familie (*Ausland*, Feb. 1, 1875); Discussion between Sir J. Lubbock and L. H. Morgan on Systems of Consanguinity (*Nature*, June 3d and Aug. 9th); On McLennan's Theory of Primitive Marriage, by J. J. Murray (Rep. Brit. Ass., 1874).

The science of social and public life is discussed by Dr. H. K. von Günther, on the Practice of Mummifying the Dead (Munich Anth. Soc., April 13, 1875); by Sir Henry Maine, on the Early History of Institutions; by Dr. Bela Weiss, on the Primitive Forms of Property (*Ausland*, No. 29, 1875, p. 565).

Important discussions on ethics and religion are: "The Origin of the Moral Idea," by C. S. Wake (Anth. Inst., June 25, 1875); "The Degeneracy of Man," by Rev. Jos. Edkins (Rep. Brit. Assoc., 1874, p. 150); "Mythology," by J. Raines (Anth. Inst., June 25, 1875); "Rhabdomancy and Belomancy," by Miss A. W. Buckland (Brit. Assoc., 1875); "Cultur und Religion," by H. K. Hg. Delff (Gotha, Perthes, 1875); and "The Theistic Conception of the World," by the Rev. B. F. Cocker, D.D. (New York, Harper & Bros., 1875).

IV. THE INSTRUMENTALITIES OF RESEARCH.

Herr von Ihering made a report to the German Anthropological Society, 1874, on new craniometrical and craniographical apparatus. On the same subject is an article by A. H. Cohausen in *Archiv für Anthropologie*, 1875, Vol. II., and one by Paul Broca in *Bulletin de la Société d'Anthropologie*, 1875, pp. 337, 377.

The new code of symbols for archæological maps, drawn up by a committee of leading savants of Europe, was explained by Mr. John Evans before the British Association at Bristol, and by Ernest Chantre before the French Association ("Matériaux," liv. xi. Supplement, 1875).

The president, council, and fellows of the Royal Geographical Society have prepared a Manual of Arctic Geography and Ethnology. A similar manual has been published by the Board of Admiralty.

The Indian Bureau of the United States and the Smithsonian Institution have published a pamphlet of Ethnological Directions, and circulars to Indian Agents and special collectors for the Centennial Exposition.

Reports of the following meetings, at which anthropological subjects were discussed, have reached us:

American Association for the Advancement of Science, Detroit, Michigan, August 11–17.

The American Philological Association, Newport, July 13–15.

British Association at Bristol, August 25 to September 1.

French Association at Nantes, August 19.

The International Geographical Congress and Exposition at Paris, August 15.

Congrés International des Américanistes at Nancy, July 19–22.

The Archæological Congress of France, Chalons, August 23–28.

The German Anthropological Society at Munich, August 9–11.

At the American Association for the Advancement of Science it was resolved to invite the next Congress of Prehistoric Archæology to meet in the United States in 1876.

A notable event was the sale at auction of the entire library of Mr. Thomas W. Field, consisting wholly of Americanas.

The following is a list of journals devoted wholly or in part to anthropology:

AMERICA:
- Contributions to Knowledge, Annual Report, and Miscellaneous Collections of the Smithsonian Institution.
- Annual Report of the Peabody Museum of American Archæology and Ethnology.
- Journal of the American Ethnological Society.
- Transactions of the American Association for the Advancement of Science.
- Transactions of the American Philological Association.
- Journal of the American Oriental Society.
- Annual Report of the Indian Commissioner.
- American Journal of Science and Art, American Naturalist, Popular Science Monthly, N. Y. Tribune Extras, N. Y. Herald Letters from New Mexico and the Stanley Expedition, Harper's Magazine, and Scribner's Monthly.

EUROPE:

Journal of the Anthropological Institute of Great Britain and Ireland.
Archæologia, and Proceedings of the Society of Antiquaries.
Archæological Journal.
Journal of the Royal Asiatic Society of Great Britain, and Transactions of the Society of Biblical Archæology, Geographical Magazine, Nature, The Athenæum, and The Academy.

Transactions of the Imperial Society of Friends of Natural Science, Anthropology, and Ethnography, Moscow.

Proceedings of the Anthropological Society of Sweden, Stockholm.
Notice sur les Musées archéologiques et ethnographiques de Copenhagen.

Archiv für Anthropologie, und Correspondenz-Blatt der Deutschen Gesellschaft für Anthropologie, Ethnologie, und Urgeschichte.
Zeitschrift für Ethnologie, und Verhandlungen der Berliner Anthropologischen Gesellschaft.
Mittheilungen aus dem Göttinger Anthropologischen Vereine.
Mittheilungen der Anthropologischen Gesellschaft in Wien.
Zeitschrift der Morgenländischen Gesellschaft.
Petermann's Mittheilungen, Gaea (the first quarter entirely devoted to prehistoric researches), Globus, Das Ausland.

Bulletin de la Société d'Anthropologie de Paris.
Matériaux pour l'Histoire Primitive et Naturelle de l'Homme.
Revue d'Anthropologie.
Indicat. de l'Archéologue et du Collectionneur.
Journal Asiatique.
Bulletin de la Société de Geographie de Paris.
La Nature, Le Tour du Monde, Revue Scientifique.

Bulletino di Paletnologia Italiana.
Archivio per l'Antropologia e la Etnologia, Organo della Societa Italiana di Antropologia e di Etnologia, Florence.

EUROPE:	Revista de Antropologia, Organo oficial de la Sociedad Antropologica Española.
ASIA:	Transactions of the Asiatic Society of Japan. Asiatic Researches, Bengal. Journal of the Royal Asiatic Society of Bombay and Ceylon.
OCEANICA:	Transactions of the New Zealand Institute.

ZOOLOGY.

Zoological explorations have been carried on during the past year in connection with the various expeditions sent out to observe the transit of Venus. Of these the labors of the Rev. A. E. Eaton and Dr. Kidder, on Kurguelen Island, have brought out the most interesting results.

During the past year also the zoology of the voyages of the *Erebus* and *Terror*, which has been unfinished for twenty years, has been completed.

In this country the corps of naturalists gathered at the headquarters of the United States Fish Commission, located for the summer season at Wood's Hole, have produced good results; and the naturalists connected with Hayden's and also Wheeler's exploring parties have met with excellent success.

Dr. Dohrn's zoological station at Naples was formally inaugurated in April. This laboratory has been already used by a number of English, Dutch, German, Russian, and Italian naturalists, and valuable researches published. A Russian naturalist of distinction, Miclucho-Maclay, has founded a small zoological station near Singapore. While in this country the Anderson School of Natural History has been abandoned for want of funds, the idea of summer schools for science-teachers has taken root, and during the past summer a successful session was held at Peoria, Illinois, and another at Cleveland, Ohio, under the name of the "Kirtland Summer School of Natural History."

Several new journals of especial value have been started in Germany: one is the *Morphologisches Jahrbuch*, edited by Professor Gegenbaur, of Heidelberg, and the *Zeitschrift für Anatomie und Entwickelungs-Geschichte* (Journal of Anatomy and History of Development), edited by W. His and W. Braune, Professors of Anatomy at the University of Leipsic.

Among new text-books, Professor Carus's "Handbuch der Zoologie" is completed by the issue of the second part of the first volume, containing a part of the Vertebrates, and the *Mollusca* and *Molluscoida*. In this country two excellent smaller text-books have appeared, Professor Tenney's "Elements of Zoology," and Professor Morse's "First Book of Zoology." The "Arctic Manual" is full of new matter relating to the natural history of Greenland.

"Life-histories of Animals, including Man," is the title of an elementary manual of comparative embryology, by Dr. A. S. Packard, Jr. It is reprinted in part from the *American Naturalist*.

The most valuable aid to the working zoologist is the "Zoological Record," the volume for 1873 having appeared during 1875.

Professor Huxley has proposed a new classification of the Animal Kingdom, based on Haeckel's; while Giard, of France, has proposed some changes, the necessity of which future studies must determine. For example, he unites the annelides *Sagitta* and the *Rotifera* with the *Mollusca*. Dr. Dohrn has suggested classifying the ascidians with the true fishes, while Giard thinks that they should be placed near *Amphioxus* (the lancelet).

The year 1875 has been prolific in speculative essays resulting from embryological and histological studies in connection with the evolution hypothesis, guesses being published which it will take decades of work to prove or disprove.

Beginning now with the lowest forms of life, and ascending to the vertebrates, it is now thought by Professor Wyville Thompson that the bodies occurring in Bathybius, and also in Globigerina ooze, to which the names of "Coccoliths" and "Rhabdoliths" have been applied, are probably either algæ of a peculiar form, or else the reproductive gemmules or sporangia of some minute plant.

From observations made by different exploring parties, it seems to be a matter of fact that the *Radiolaria* or *Foraminifera*, as well as the diatoms, inhabit the ocean all the way to the bottom; *i. e.*, that all the calcareous shells forming the ooze at the bottom have not fallen down from the surface. Several new American rhizopods have been described by Professor Leidy.

Professor Allman has given in his anniversary address to the Linnæan Society a sketch of "Recent Progress in our Knowledge of the Ciliate Infusoria." The same thing in briefer space has been attempted by Dr. Packard in the *American Naturalist* for all the *Protozoa*, especial stress being laid on their modes of reproduction.

Further studies on the *Gregarinæ* have been made by A. Schneider. It is well known that these low *Protozoa* on maturing encyst themselves and break up into a number of spores (pseudonavicellæ and psorospermeæ). In two genera, *Gregarina* and *Stylorhynchus*, Schneider has found a special apparatus for the dissemination of these spores.

A detailed account of our North American sponges has been begun by Professor Hyatt, and it is now hoped that these neglected animals may be worked up. The first paper, on the North American *Poritidæ*, has an excellent plate, and contains references to certain foreign species. Mr. N. J. Carter has published a classification of the sponges, in which the orders and families, and groups within families (not genera and species, however), are characterized. The fresh-water *Spongilla* has been found by Mr. Sorby to contain constituents, such as varieties of chlorophyl and xanthophyll and lichnoxanthine, all of which occur in plants.

A gigantic hydroid polyp was dredged by the *Challenger* Expedition, measuring seven feet four inches high, and the crown of tentacles nine inches across from tip to tip of the expanded (non-retractile) tentacles. It occurred at the depth of 1875 fathoms, on the 17th of June, in latitude 34° 37′ north and longitude 140° 32′ west, and again, four feet in height, at the enormous depth of four statute miles, on the 5th of July, in latitude 37° 41′ north and longitude 177° 4′ west. The stem is enormously extensile, of a pale pink color. It is either a species of *Monocaulus* or an allied form. The proximal range of tentacles number about a hundred, and these are about four inches long, and almost transparent in life. The ovisacs are in close tufts of a maroon color, just at the base of the proximal tentacles. "The walls of the body-cavity," writes Professor Wyville Thompson, "were yellowish, and seemed to contain some vertical rolls of granular matter, and the hypostome terminates in a fringe of about forty-eight or fifty extensile tentacles around the mouth." Professor Allman adds "that the enormous depths from which this colossal hydroid has been brought up should favor the development of gigantic representatives of the diminutive forms of shallower zones, and that in the tenants of these sunless regions of the sea we should find color not less vivid than that of their light-loving relatives, are facts full of significance." It is also to be noticed that the old idea of pressure at great depths of the sea is entirely incorrect, as this animal is soft and jelly-like as in the *Corymorpha* of shoal water. No deep-water hydroid polyps, as Allman remarks, produces medusæ, not being able to endure, "either before liberation from their parent hydroid, or for a period however short in their free state, the darkness and pressure and other conditions to which the dwellers in the deep are exposed."

More light has been thrown on the distribution and younger stages of the gigantic polyps *Umbellularia* by Dr. Willemoes-Suhm of the *Challenger* party. In the Antarctic Sea it has occurred as low down as 2600 fathoms.

The growth of the common coral, *Madrepora cervicornis?* in the Florida Keys is estimated by Professor Joseph Le Conte to be not more than three and a half to four inches per annum.

Little has been done in the Echinoderms, except by Professor Carpenter, who from his examination of the nervous and generative systems of *Comatula*, thinks that we should be justified in removing the Crinoids much farther from the rest of the Echinoderms than before. In fact, he thinks they have little in common beyond the calcareous network of the skeleton. To show how abundantly these crinoids may occur, Dr. Carpenter states that he had learned from a trustworthy observer that after a recent hurricane in the West Indies a vast number of *Pentacrini* had strewed the shore of Barbadoes, in all stages of growth, from one inch to eighteen inches in length; but unfortunately no naturalist was at hand to reap the rich harvest.

Further studies on the embryology of the *Mollusca* have been made by M. Giard, Ussow, and Lankester. The two latter have published their observations on the Cephalopods, while the researches of Giard were made on *Lamellaria perspicua*, a gastropod. The development of *Lamellaria* requires two or three weeks, the eggs being laid in February and March. The embryo passes through an invaginate-gastrula condition, as in certain nudibranch mollusks (*Dendronotus* and *Goniodoris*). The first embryonic, deciduous shell is of a nautiloid form, and presents two dorsal and two lateral keels, like the shell of *Atlanta*. The second shell is more simple, like that of *Carinaria*, or of the embryos of the Nudibranches. Giard claims that they have the same relations to each other, and the same relative signification as the nauplian cuticle of the embryos of the Cirripedes and the carapace of the Archizœa inclosed under that cuticle. He does not think that the second shell is the origin of the calcareous shell of the adult *Lamellaria*.

A beautiful memoir on the early stages of the Pteropods and Heteropods, with admirable illustrations, has been published by Fol in Lacaze-Duthiers's "Archives."

The life-history of certain mollusks, abstracted from the works mostly of European observers, has been given by Dr. Packard in the *American Naturalist*. Of the mode of development of the oyster we have much new information by Salensky (1874) and Gerbe (1875). It appears that while some lamellibranch mollusks, such as the Unio, are bisexual, the oyster is hermaphroditic. The eggs, which are yellow, after leaving the ovary are retained among the gills. A single oyster may lay 2,000,000 eggs. The spawning time of the oyster in Europe is from June to September. During their development the eggs are inclosed in a creamy slime, growing darker as the "spat" (the term applied to the young oyster) develops.

The course of development is this: After the segmentation of the yolk, the germ divides into a clear peripheral layer, and an opaque inner layer containing the yolk, and representing the inner germinal layer. A few filaments or large cilia arise on what is to form the "velum," or the future head. The shell then begins to grow out at what is destined to be the posterior end of the germ, and before the digestive cavity arises. At this stage the two-layered germ is said by Salensky to represent the "plannla" of the sponge. The digestive cavity is next formed ("gastrula" stage), and the anus appears just behind the mouth, the alimentary canal being bent at right angles. Meanwhile the shell has grown enough to cover half the embryo, which is now in the so-called veliger state, the velum being composed of two ciliated lobes in front of the mouth-opening. The young oyster, as figured by Salensky, is directly comparable with the "veliger" or larva of the Cardium or cockle-shell. Soon the shell covers the entire larva, only the ciliated velum projecting out of an anterior end from between the shells. In this stage the larval oyster leaves the mother, and swims around in the water, the cilia of the velum keeping up a lively rotary motion. In this state Lacaze-Duthiers observed it for forty-three days without any striking change in form, except that the velum increased in size, and the auditory vesicle appeared, containing several otoliths, which kept up a rapid motion. But still the gills and heart were wanting. Of its further early history we know but little, except that it becomes fastened to some rock and is incapable of motion. The oyster is said, by the appearance of its shell, to be three years in attaining its full growth, but this statement needs confirmation. M. Gerbe has during the past year, according to *La Revue Scientifique*, cleared up some obscure points in the development of oysters, but what they are is not stated.

The development of a gigantic cuttle-fish, of an unknown species, has been worked out by Grenacher. The mass of eggs was thirty inches long. After segmentation of the yolk, unlike other cuttle-fishes known, the embryo assumes a spherical form, with a band of cilia, and is thus like the ciliated embryos of certain lower mollusks. This spherical stage is also remarkable for the early appearance of the mantle, with the contractile pigment-cells (chromatophores). The embryo soon elongates, the mantle grows, the eyes and arms bud out, and the form of the adult is rapidly sketched out.

Professor Hyatt has continued his studies on the Ammonites, having described new forms of Jurassic and cretaceous Ammonites collected in South America by Professors J. Orton and C. F. Hartt; and in another paper remarks on two new genera, *Agassiceras* and *Oxynoticeras*. In a memoir on the "Biological Relations of the Jurassic Ammonites," in course of preparation, but of which an abstract has been published, he traces the history of the evolution of the order of Ammonoids, showing that the characteristics of the first three stages of the embryo were inherited from a very early period. These were, first, the sac-like shell of the embryo, containing the equally sac-like beginning of the siphon; second, the beginning of the true shell or apex, with its nautilus-like septum and peculiar nautilus-like umbilicus; third, the depressed and goniatite-like continuation of the form of the shell, with its accompanying goniatitic septa. These, of course, represent only their most advanced stage in the Ammonites proper of the Jura and Trias; they are, when first observed in the Silurian and Devonian, exceedingly variable in the length of the periods and other important characteristics, even between the varieties of different species. They become invariable in the young as embryonic characteristics only after the lapse of time represented by the Silurian, Devonian, and Carboniferous periods. This variability in the same species in the Silurian shows how recently they were inherited, and their invariability in every individual of the Jurassic shows the results of the long ages of inheritance through which the group has passed between that period and the Silurian epoch.

A number of descriptive papers appear in the Proceedings of the Zoological Society of London, and the German and French conchological journals. Among these, Beddome's "Descriptions of some new Operculated Land-Shells from Southern India and Ceylon," Mr. Guppy's notes on West Indian shells, and descriptions of new shells from Queensland, by Mr. Brazier, are noteworthy; while in this country the report on the mollusca of Hayden's Survey of the Territories, by Mr. E. Ingersoll, gives new information relating to the distribution of land-shells in Colorado. It seems that no land-shells were found on the eastern slope of the Rocky Mountains (though they do exist there). Altitude seemed to have little influence upon their range so long as other favorable conditions were present. The number of species which occurred was very small, owing to the dryness of the country. The *Pupæ* were perhaps the most common forms, increasing southward, while specimens of *Vertigo Californica* and *Pupilla alticola* were numerous every where in the mountains as high up as timber grows.

Our knowledge of the lower worms has been advanced by the papers, finely illustrated, of Mr. MacIntosh, upon the structure of the Nemertian worms, while his work on the worms of Great Britain has been issued by the Ray Society.

Dr. Habrecht has described a number of new genera and species of these worms, and drawn attention to the minute structure of the nerve-ganglia. Hæmoglobin was detected by means of the spectroscope in the nerve-tissue of two species of *Meckelia* and in true red blood-disks of *Drepanophorus.* He has also noticed the formation of an invaginate gastrula in the early stages of *Borlasia olivacea.*

In last year's report we noticed the work of M. Villot on the structure and development of the Hair-worm (*Gordius*). He finds that the young *Gordius aquaticus* first makes its way into insect larvæ, such as *Chironomus*, and becomes encysted; after which it finds its way with its host into the alimentary canal of fishes, where it is again encysted. It escapes from this position in the spring.

Further researches on the ascidians by Ussow bring him to the conclusion that the Tunicates are not Mollusca. "Even," he says, "without taking into consideration the modes of embryonal development, a comparison of the plan of structure of the different mollusca with that of the Tunicata suffices to refer the latter with more propriety to the Vermes. The simple cardiac tube, the absence of the œsophageal ganglia and their commissure, the complete absence of the foot, the curvatures of the intestinal canal directed toward the heart, the existence of the outer mantle, and the peculiarities of its structure, mode of formation, and chemical constitution, the variability in the direction of the contractions of the cardiac tube, etc., all draw a more or less sharp boundary-line between the Tunicata and the Mollusca. The Tunicata approach most closely to the Bryozoa." On the other hand, he points out important characters in which the Tunicates approach the worms; while from the presence of a *chorda dorsalis*, the type of development of the central nervous system, and the relation of the alimentary tube to the bronchial sac, the Tunicata are related to the Vertebrata. Ussow goes so far as to adopt Oscar Schmidt's view, according to which the Tunicates form a special class of *Protovertebrata.*

From his study of the curious worm *Sagitta* M. Giard supports the prevalent view that it is a worm standing nearer the annelids than any other animals. In his essay he notes the characters these animals share with others leading a pelagic life, which are as follows:

1. An extreme transparency of all the tissues, which renders the animal completely invisible, and enables it to escape easily from its enemies. We observe it in the *Noctilucæ*, the *Siphonophora*, the *Medusæ*, the *Ctenophora*, the Heteropod and Pteropod mollusks, the *Salpæ* and *Pyrosomata;* in *Sagitta*, *Tomopteris*, and *Alciope*, and, lastly, in the *Leptocephali*, among fishes.
2. The unusual development of certain organs of sense, especially the eyes, and sometimes the auditory apparatus, as in the Medusæ and the *Appendicularia*, and in *Mysis*.
3. The small size of the digestive tube.
4. A considerable development of the organs of generation, and great fecundity.
5. A great number of pelagic animals present the phenomena of phosphorescence, such as the *Noctilucæ*, many *Medusæ*, the *Pyrosomata*, and *Phyllirhoë bucephala*. This phosphorescence, which is manifested especially when the animals are excited or alarmed, no doubt acts as a protection, and stops the pursuit of some enemies.
6. Their social life, as many of them swim in large masses.

M. Villot has made some observations on the migrations and transformations of certain marine parasitic Trematodes. Two very different Distomæ live in the intestine of the sea-lark, a kind of plover. One is *Distoma leptosomum*, and the other *D. brachysomum*. These two parasites are found in the larval state, still encysted, in the gizzard of the sea-lark; in the small intestine they are further developed, and when they arrive in the rectum they have acquired their adult size, and laid their eggs, which are ready to be expelled. As to the tadpole-like young (cercariæ) of these Distomas, those of *D. brachysomum* become encysted in small isopod crustaceans of the genus *Anthura;* while those of *D. leptosomum* are encysted in a small mollusk—*Scrobicularia tenuis*. The crustacean and mollusk both serve as food for the sea-lark. Professor J. Leidy notices some parasitic worms in the Proceedings of the Academy of Natural Sciences at

Philadelphia, while the anatomy of *Tænia mediocanellata*—a tape-worm more common in Europe than *T. solium*—is discussed by Dr. Welch in the *Quarterly Journal of Microscopical Science.*

A synopsis of North American fresh-water leeches, with descriptions of some new species, with figures, has been prepared by Professor A. E. Verrill for the Report of the United States Commissioner of Fish and Fisheries.

The *Crustacea* have been studied anatomically by Claus, in an illustrated essay on the higher Copepoda, in Siebold and Kolliker's *Zeitschrift.* The early condition of the nervous system of the king-crab (*Limulus*) has been described by Dr. A. S. Packard. Instead of the cephalothoracic ganglia being united to form a ring around the œsophagus, they are in the larva separate, five pairs of large ganglia corresponding to the five anterior pairs of limbs. The brain of the king-crab differs remarkably from that of the normal crustacea—*i. e.*, the lobster and crab—in sending off no antennual nerves, but only two pairs of optic nerves, there being, in fact, no antennæ in *Limulus.* While there is a general analogy in the form of the anterior portion of the nervous chord of *Limulus* to that of the spiders and scorpions, it does not prove that the king-crab is an arachnid, for there are other remarkable differences that forbid our placing the king-crab among the arachnids, and they should be regarded as very aberrant crustacea. Packard also described certain organs in *Limulus* as probably renal in their nature, and perhaps homologous with the green glands of the normal crustacea.

Additional facts regarding the metamorphoses of the spiny lobster (Palinurus) of the Mediterranean have been discovered by Gerbe. By his study of the Phyllosoma, or larva state of the Palinurus, he concludes that in the higher crustacea the peripheral portion of the arterial system very slowly arises, and during the early stage of the change the bloodvessels ramify among the tissues like the roots of a plant.

In descriptive crustaceology we have a "Synopsis of the Higher Fresh-Water Crustacea of the Northern United States," by Professor S. I. Smith, containing full descriptions of a number of interesting forms, including *Palæmon* *ohionis*, a shrimp used for food in Indiana, and another shrimp—*Palæmonetes exilipes* of Stimpson—which occurs in Lake Erie as well as South Carolina and the fresh-water streams of Florida. The most remarkable shrimp-like form, however, is the *Mysis relicta*, first described by Lovén, from the inland lakes of Sweden. It occurs at various depths in Lakes Superior and Michigan, where it forms a large part of the food of the whitefish.

This Mysis is so closely allied to the *Mysis oculata* of the northern and arctic seas, being regarded by some as a simple variety, that its occurrence in these lakes so far from the sea is, as Smith states, a fact of peculiar interest, which goes far toward proving the marine origin of a part of the fauna of our great lakes. Dr. Stimpson believed that the great lakes had in recent (Quaternary) times been isolated from the sea by a rise of land. Very probably, at the time when the sea had access to these basins, the communication was somewhat narrow and deep, and the influx of fresh water from the surrounding country was sufficient to occupy entirely the upper stratum, while the heavier sea-water remained at the bottom.

After the basin had become separated from the ocean by the rise of the land, the bottom water must have become fresh by diffusion very slowly to allow of the gradual adaptation of the crustaceans to the change of element." Professor Smith adds that at the time Lake Ontario was a part of the great St. Lawrence valley sea, there was, very likely, no insuperable barrier in the Niagara River to the upward migration of active swimming animals like *Mysis*, and some of the inhabitants of the upper lakes may have reached their present homes by this route during the northern movement of the fauna at the close of the Quaternary epoch. "On the other hand, *Mysis relicta*, although originally derived from the strictly marine species *M. oculata*, may have existed long enough to have had the same history as some of the strictly fresh-water species, known to be common to Northern America and Northern Europe, since it has much the same geographical distribution." Other crustacea are mentioned in Professor Smith's "Sketch of the Invertebrate Fauna of Lake Superior," in the same report.

The habits of the blind crawfish of the Mammoth Cave have been studied by Mr. F. W. Putnam. It takes almost no food, though the eyed species (*Cambarus Bartoni*) readily eats any food offered to it. On being startled, the blind species darts backward, extending its antennæ, and stands as if on the alert for danger. Milk-white specimens, on changing their skins, were afterward of the same color. It did not change its color after shedding its shell twice, or after living in full light of day, and often for hours in the sunshine, over five months. On April 20 the same specimen cast its shell for the second time, within three months of the time it last moulted. During this period it did not feed more than three or four times, and then only ate sparingly.

From observations made on the reproduction of lost parts in the blind crawfish, it appears that the parts, such as the legs and antennæ, are not reproduced in perfection after one moult, but that each time the shell is cast they are more nearly perfect than before. In the instance observed it required three moultings before the great claw attained nearly its full size, while an additional moult is necessary to perfect the limb. The posterior legs, on the contrary, are perfected in two moultings, and, in the case observed, in about five months from the time they were lost. The antennæ are reproduced more rapidly, and approach their full size in one moulting. During the five months the animal was in confinement it did not increase in size. Extremes of temperature did not affect the blind crawfish, as several specimens were kept without harm for several days in a heated room, and were exposed for weeks to such intense cold that the water in the jars was frozen.

A number of new North American sow-bugs, or *Oniscida*, are described by Stuxberg in the Proceedings of the Royal Swedish Academy. The same author describes in the "Annals and Magazine of Natural History" a number of new forms of *Lithobius* (a small centipede) from California and Mexico.

The studies of the Russian zoologist Metschnikoff on the embryology of the thousand-legs (or chilognathic Myriapods) have been supplemented by a beautiful memoir on the early history of *Geophilus*, a long, slender form allied to the centipedes (*Chilopoda*). In this form, as in other Myriapods, the yolk undergoes total segmentation, and the primitive band surrounds one half of the yolk. In the next stage observed the antennæ and three pairs of jaws are developed (only two in the thousand-legs). In a succeeding stage the primitive band is much longer than before, and the head and tail approach nearer to each other, while there are now from forty-four to forty-six body-segments, most of them bearing rudimentary appendages, though there are none as yet on the end of the body. In a succeeding stage the head is much larger, the body longer and curved over the yolk, while the egg-shell breaker is situated on the second maxillæ. In a following stage the body is still more elongated and the joints of the antennæ appear. The embryo now slips out of the split shell, the body being very long and cylindrical, not yet flattened as in the adult animal.

The young Geophilus, and probably nearly all the centipedes, undergoes no metamorphosis, being born with nearly the full number of feet, while the young thousand-legs or millepede has but three pairs when hatched. We now have, thanks to Metschnikoff's other papers on the development of the Chelifer and Scorpion, and to the researches of other observers, quite full information regarding the life-histories of the tracheate Arthropods, or insects.

Unusual activity has been shown by students of the spiders both in Europe and this country. The writings of Hentz have been collected and republished by the Boston Society of Natural History, containing the text and plates of his papers in the memoirs of that society, with the addition of several excellent plates drawn by Mr. J. H. Emerton, with additional notes by him. A number of new species of spiders from Southern Europe and North America, belonging to the genus *Erigone*, are described by the Rev. O. P. Cambridge. Dr. Thorell has described a number of new forms from New Caledonia, Madagascar, and Reunion Islands. It appears that the *Nephila edulis* Vinson, of New Caledonia, a large spider allied to our *Nephila plumipes*, whose habits have been studied by Professor Wilder, is used by the natives as an article of food, while in Madagascar *Nephila Madagascariensis* Vinson, is also eaten, "en l'accommodant avec de l'huile ou de la graisse" (see Vinson, "Voyage à Madagascar," p. 126). He also gives some notes on venomous spiders. The so-called venomous spider of Madagascar, called by the natives "foka" or "fook," is thought by Vinson to be probably harmless. Allusion is made by Thorell to the supposed poisonous nature of the *Lathrodectus Curacaviensis* of Curaçoa, South America. It is a congener of the poisonous Lathrodectus of Southern Europe and the Southern United States.

He has also published in the Proceedings of the Boston Society of Natural History a descriptive account of the spiders of Labrador, based on specimens collected by Dr. A. S. Packard, Jr.

The spiders inhabiting the caves of Kentucky and adjoining states have been studied by Messrs. Packard and Emerton, the latter affording descriptions and drawings of these interesting forms, some of which are blind, or with defective eyesight, and all more or less bleached. The two largest and consequently most ancient caves, Mammoth and Wyandotte, and in which the physical environment of the species is most unvarying, have but one species each. In the smaller caverns of Carter County, Kentucky, and the two Weyer's caves, the number of species and variation in the individuals are greater than in the previously mentioned caves. In each set of caves (Carter's and Weyer's) there are three species, to one in Mammoth and Wyandotte caves. What constitutes the food of these diminutive, weak, sedentary spiders it is difficult to conjecture, unless it be certain minute delicate mites or young Poduras. They spin no web, except some of the spiders of Weyer's Cave. The small flies (*Sciara* and *Chironomus*) are too large and bulky to be captured by them. The probable insufficiency of food, as well as light, may account for their small size and feeble reproductive powers. Mr. Emerton reports six species of cave spiders, all undescribed except one.

A few mites are known to inhabit the sea; the British species have recently been described and figured by Mr. G. S. Brady. Eleven species are now known to inhabit the coast of Great Britain, a number of which were obtained by the dredge, while one form (*Halarachne halichœri*) is parasitic in the posterior nares of a seal (*Halichœrus gryphus*).

Coming now to the winged insects, we can not say that much has been done during 1875 in the study of their development or anatomy. Unfortunately the mass of new species is so great, and the insect-fauna of the earth, even of the older portions of the globe, as, for example, the older United States, is so little known, that students are still, and will be for years, busied with the merely preliminary work of descriptive entomology.

As a contribution to animal psychology, Lubbock's second paper on Bees, Wasps, and Ants claims notice. The merit of this tract is that a daily journal of the doings of individual insects is given, from which the reader may judge as to the correctness of the author's conclusions. He enumerates a number of facts showing that "some bees, at any rate, do not communicate with their sisters, even if they find an untenanted comb full of honey, which to them would be a perfect Eldorado." So far from having been able to discover any evidence of affection among them, "they appear to be thoroughly callous and utterly indifferent to one another." Their alleged devotion to the queen is "of the most limited character." That bees can distinguish scents is certain. While acknowledging the truth of Langstroth's statement that the bees of one hive know each other, he thinks it is by the sense of smell, and not by an act of the intellect. Bees differ as to the facility with which they find their way about. He then says, if "bees are to be credited with any moral feelings at all, I fear the experience of all bee-keepers shows that they have no conscientious scruples about robbing their weaker brethren." Regarding the industry of ants, he gives quite full statistics. He then gives some interesting experiments showing that ants communicate news to each other.

Frequent reference is made by Lubbock to Forel's new work, "Les Fourmis de la Suisse," a quarto work of 455 pages, with two plates, published at Zurich in 1874. As this is the most important work on insects of the last two years, we translate an abstract of its contents given by Blanchard in *La Revue Scientifique.* The work is worthy to succeed that of the author's fellow-countryman, Pierre Hüber. After describing the species, the author considers the relations between the peculiarities of structure and the adaptation for work or war. The descriptions are followed by anatomical and physiological studies of different organs, accompanied by interesting remarks concerning instinct and intelligence. The doings of ants in rendering mutual services, or in caring for the larvæ or pupæ, have been the subject of curious experiments. Forel, on soiling and deforming the silken cocoons containing the pupæ, always found the next morning that the ants had restored them to their original form and primitive whiteness. Hüber spoke of the precision with which a column of ants moved, and the perfect order the army observed on a long march. Forel, however, shows that this precision would be impossible unless the ants were careful to preserve order. An ant carrying a heavy cocoon, wholly taken up with its burden, is incapable of giving attention to any thing else. Some wander, while others, better assured of their course, go straight on. After much hesitation the wanderers again find the road, as shown by the readiness with which they march on. This is regarded by Forel as an evidence of an excellent memory.

Forel also studied the power of reproduction in the workers. It is known that they sometimes lay eggs. He has shown that by their whole structure such individuals are intermediate between the fecundated females and the workers or neuters. Their ovaries are sometimes completely, sometimes only partially, developed.

He also affords a number of new observations on the architecture of these creatures. He finds that the nests of the same species sometimes vary in their interiors. Forel doubts whether certain ants live in the nests of others, as if parasitic. He finds that two kinds of ants lodged in the same nest occupy separate apartments, with walls separating them. Forel has studied better than any one else the habits of the isolated fecundated females. He has studied and created alliances between the industrious species and those incapable of rearing their young; he has watched their battles, and also noted the influence of temperature and of light on the movements of the ants.

The functions of the anterior pair of ganglia, or so-called brain, of a water-beetle (*Dytiscus marginalis*) have been studied by Faivre. He believes that these ganglia preside especially over the movements of deglutition; that they determine not only the contraction but the dilatation of the pharyngeal sphincter-muscle, which reacts at the same time with the recurrent on the cardiac sphincter. The power peculiar to this nerve-centre can be set in play by impressions transmitted sometimes from behind forward, or the reverse. He associates through the medium of the brain, to which are attached communicating nerves, the acts of prehension and of mastication to the swallowing of food and the passage of food into the stomach and intestine. The subœsophageal ganglia is the centre, under the influence of which it reacts with the most energy. In brief, the frontal (supraœsophageal) ganglia, distinct by their special rôle from the other nervous centres of the ganglionic chain, approach the former (subœsophageal) by their essential functions as well as structure.

Further contributions to the relations of insects to plants are to be found in Lubbock's "British Wild-flowers in Relation to Insects," and in Hermann Müller's papers in *Nature.*

The subject of hermaphroditism in the moths (or more properly *gynandromorphism*) has been discussed by Dr. A. S. Packard, Jr., who describes and figures two gynandromorphs of *Callosamia Promethea.* One is a female, with the antenna and wings on the right side masculine, and the other is a male, with the antenna and wings on the right side more like the male than the female. These two cases may be regarded as extreme examples of what may be called *peripheral gynandromorphism;* namely, where the trunk (head, thorax, and hind-body) are not affected, but only the appendages and scales, including the wings, feet, and antennæ; the head and genitals not being affected. The least-marked example of this sort is one described by Westwood, who states that he had an orange-tip butterfly (*Anthocaris cardamines*) which was female in every respect, except that on the tip of one fore-wing were about a dozen of the bright orange scales which characterize the male. It is not known that any Lepidoptera with the internal genital organs affected have been examined, as the examples thus far have not been preserved in alcohol. The best-defined cases of this sort are those described in the honey-bee by Siebold. In these cases the internal and external sexual organs are mixed together much as the other external characters. The sting, with its vesicle and gland, was present, though in a soft state, in the drone, and in the female the ovaries and also spermaries were present, though the ovaries contained no eggs. As to the cause of so-called hermaphroditism, Siebold's explanation that it is due to an imperfect fecundation of the ovum seems most probable. These cases seem to be paralleled by the occurrence of hybridity between two species, the result being an irregular fusion of the characters of both species. Both seem to indicate that sexual characters, as well as specific characters, are determined at the time of impregnation.

Mr. Scudder's discovery of well-preserved remains of the abdomen of a larval dragon-fly in the coal-measures of Cape Breton sets back a long ways the existence of these insects, the earliest remains heretofore known having occurred in the Lias formation.

As a contribution to fossil entomology, the splendid memoir of Mr. Scudder on fossil butterflies is noteworthy. Nine well-authenticated species of fossil butterflies are now known, all from the European tertiary formation, the earliest known forms occurring in the lower beds. Three of these insects belong to the highest families of butterflies—Nymphales—four to the Papilionidæ, and two only to the Urbicolæ (Hesperians). The allies of four of these fossil butterflies now live in the East Indies; those of three in sub-tropical North America, and one of them in the north temperate zone of both Europe, Asia and America; and those of one in the Mediterranean region. Three out of the four species whose living allies are to be sought in the East Indies come from the older deposits of Aix, and only one of the two remaining Aix species shows special affinities to American types; "We thus find here, as among other insects and among the plants, a growing likeness to American types as we pass upward through the European tertiaries.

"The study of the floras of the European tertiaries has proceeded so far that in most cases we are able to find, in the very beds where the butterflies occur, plants which we may reasonably judge to have formed the food of these insects in their earlier stages. In but a single instance is the family of plants upon which it was necessary, or almost necessary, to suppose the caterpillar fed, entirely absent from tertiary strata; and since this family is the Cruciferæ, which in its very nature could scarcely have left a recognizable trace of its presence, the exception has no force."

Professor Weismann's work on "Seasonal Dimorphism" in butterflies shows that several so-called species are simply varieties appearing at different parts of summer, either the beginning or close, and that this variation does not occur in the larva state, but is probably due to the different durations of the pupa state. He thinks they are the same in effect with climatic varieties, and that they were induced originally by changes in the climate of Europe during the coming and going of the glacial period. The essay also throws light on the origin of climatic varieties.

The effect of the glacial period on the distribution of insects in North America is discussed by Mr. Grote. The tops of the White Mountains and the Rocky Mountains in Colorado offer us particular kinds of insects, living in an isolated manner at the present day, and confined to their respective localities. In order to find insects like them we have to explore the coast of Labrador, and the northern portions of the North American continent in regions offering analogous conditions of climate to those existing on the summits of these mountains. The genera *Œneis* (Chionobas) and *Brenthis* among the butterflies, and *Anarta* and *Agrotis* among the moths, are represented by the same or similar species in all of the above-mentioned localities. In the case of the White Mountain butterfly, *Œneis semidea*, we have a form sustaining itself in a very limited alpine area on the top of Mount Washington.

The question comes up, with regard to the White Mountain butterfly, as to the manner in which this species of *Œneis* attained its present restricted geographical area. Mr. Grote answers it by the action attendant on the decline of the glacial period. Many of the features of the advance of the glacial sheet were repeated in the reverse order on the subsidence of the main ice-sheet or glacial sea. The local glaciers appeared again, separate from the main bodies of ice, and filled the valleys and mountain ravines, thus running at variance with the main body of the glacier, being determined by local topography. A reversal of the temperature shortened the winters and lengthened the summers. Ice-loving insects, such as the White Mountain butterfly, hung on the outskirts of the main ice-sheet, where they found their fitting conditions of temperature and food. "The main ice-sheet had pushed them insensibly before it; and during the continuance of the glacial period the geographical distribution of the genus *Œneis* had been changed from a high northern region to one which may well have included portions of the Southern States. And on its decline the ice-sheet drew them back again after itself by easy stages; yet not all of them. Some of these butterflies strayed by the way, detained by the physical nature of the country, and destined to plant colonies apart from their companions."

When the main ice-sheet left the foot of the White Mountains, some of these *Œneis* butterflies were left behind. "At a height of from 5600 to 6200 feet above the level of the sea, and a mean temperature of about 48 degrees during a short summer, the White Mountain butterflies (*Œneis semidea*) yet enjoy a climate like that of Labrador within the limits of New Hampshire. And in the case of moths an analogous state of things exists. The species *Anarta melanopa* is found on Mount Washington, the Rocky Mountains, and Labrador. *Agrotis Islandica* is found in Iceland, Labrador, the White Mountains, and perhaps in Colorado. As on islands in the air, these insects have been left by the retiring ice-flood during the opening of the Quaternary."

Some studies by Mr. W. H. Edwards lead him to differ from Mr. Scudder's conclusions in relation to the two broods, vernal and æstival, of two butterflies, *Argynnis* (Brenthis) *myrina* and *bellona*, which were published in the *American Naturalist* in 1872. Mr. Edwards finds that in *Argynnis myrina* the butterfly of the fall brood emerges from the chrysalis about the 1st of September, lays eggs on or before the 15th, the larvæ hatch between the 20th and the 24th, and go at once into hibernation, to awake in May, and reach the chrysalis state about the middle of June, and the butterfly state about the 25th of June. If any of the summer brood of larvæ hibernate after their third moult (a fact not established), then the larvæ of both broods would awake at the same time and become butterflies at the same time, making the summer brood. It is to be observed that the several stages of the same brood of larvæ do not occur in exactly the same periods of time. From eggs laid on the same day, by the same female, some of the larvæ hatched will reach the chrysalis state several days before others. In the larger species of *Argynnis* there will be such a difference, amounting to two or three weeks. Therefore some of the larvæ which hibernate at the third moult may be retarded so that their butterflies shall emerge contemporaneously with those which proceed from the larvæ that hibernate as soon as they leave the egg. The case is parallel with that of *Phyciodes nycteis*, and with that of *Apatura celtis*, both double-brooded species, and both disclosing larvæ from the summer brood which hibernate when half grown, while a part of the brood go on to chrysalis and give the fall brood of butterflies, these again producing larvæ which also hibernate. (In both the last hibernation begins after the larva is half grown—*i. e.*, after the third moult in *nycteis*, and after the second in *celtis.*) Mr. Edwards claims that Mr. Scudder has made a hypothetical case which is precisely the actual case that he (Edwards) has above indicated. Scudder's example is as follows, to use his own words: "Should the season be so long that the *second brood could lay eggs*, the caterpillars would then be forced to hibernate as those of the æstival series, and *become members* of that series the next year. Thus the vernal series would continually feed the æstival." Moreover, in no species do the several preparatory stages of its members run even. On the contrary, in any, whether single or double brooded, there will be found by different females eggs freshly laid, eggs ready to hatch, young larvæ and mature larvæ, all at the same time. By this means there is kept up for a long period, often for weeks, a succession of newly emerged butterflies of the same brood, and the newer and older are constantly mating. On one day in September of last year he cut a branch of wild senna (*Cassia*), on which at the moment were newly laid eggs of *Terias nicippe*, larvæ in every stage of growth, and a butterfly of the same species just emerged, and still resting on the empty shell of its chrysalis.

Our knowledge of the transformations of the Lepidoptera has been increased by an illustrated account by Mr. Scudder of the life-history of *Eumæus atala*, a butterfly which feeds on the *Zamia* in Florida. Several Limacodes larvæ are described by Mr. Wetherby, and other larvæ are described in the *Canadian Entomologist*, and by Mr. Henry Edwards in the Proceedings of the California Academy of Sciences.

An interesting contribution to our knowledge of the insect fauna of islands is afforded by the Rev. A. E. Eaton's researches on Kerguelen Island, while attached as naturalist to the Transit of Venus Expedition. Nearly all the insects were remarkable for being either wingless or with very short wings. Of the flies (Diptera), one species had neither wings nor halteres. Dr. J. L. Le Conte, in his presidential address before the American Association, brings forward some valuable facts in the geographical distribution of insects in North America.

In descriptive entomology there are the usual papers in journals and transactions. The *Canadian Entomologist* contains descriptions of North American insects, while *Psyche*, published by the Cambridge Entomological Club, contains an elaborate bibliographical record, in which a list is given of all writings upon entomology published in North America, and of all foreign writings upon North American entomology, and a brief notice of the contents of each.

Especially worthy of notice are descriptions and synonymical catalogues by Hagen, Scudder, Ostensacken, Grote, Morrison, Chambers, H. Edwards, and others; while in the Proceedings of the Zoological Society are handsomely illustrated papers by Butler. Professor Zeller continues in the Transactions of the Vienna Botanical and Zoological Society his elaborate descriptions of North American moths. In economical entomology the report of Mr. Riley is replete with useful information, particularly regarding the destructive grasshopper and the grape *Phylloxera*.

Coming now to the Vertebrates, we learn that M. Gerbe has studied in the fish-parks at Concarneau the embryology of the rays, embracing all the modifications that the eggs of these fishes undergo from the time they enter the oviduct to that of their exclusion. The swimming-bladder of fishes has been studied by M. Moreau from the side of experimental physiology. He concludes that it is a hydrostatic organ, and not an organ of locomotion.

In a work on the origin of the vertebrates, Dr. Dohrn indulges in some speculations as to the ancestry of these animals. His embryological investigations lead him to seek for the probable ancestors of the vertebrates among the Arthropods (crustacea and insects), rather than the Tunicates or Ascidians; and to revert to the views of the elder St. Hilaire, who described insects as vertebrates which walk with their backs downward, rather than to those of Kowalevsky and others, who trace the line through the Ascidians and the lancelet. So far from being the representative of the original vertebrates, the *Amphioxus* is regarded by Dr. Dohrn as a degenerate descendant of the cyclostomous fishes, and the so-called larvæ of the Ascidians are the result of a still longer-continued process of degradation.

On account of these and other speculations, renewed attention is being paid to a study of the embryology and anatomy of *Amphioxus*, the lancelet. Mr. Balfour considers that it is not necessary to conclude that *Amphioxus* itself was the ancestor of the vertebrates, but merely that the earliest stages of development of this supposed vertebrate ancestor were similar to those of *Amphioxus*. The egg of *Amphioxus* differs from that of other vertebrate animals in having less food-material or yolk, and Balfour thinks that this accounts for the differences in the early stages of the embryo. Still he thinks that all the modes of development found in the higher vertebrates are to be looked upon as modifications of that of *Amphioxus*. One common feature which appears prominently in reviewing the embryology of vertebrates as a whole is the derivation of the middle germ-layer (mesoblast) from the third or inner layer (hypoblast), though it should be stated that so high an authority as Kölliker thinks that the middle layer is derived from the outer one. Among the invertebrates, however, the middle germ-layer is derived from the inner germ-layer.

Professor Huxley publishes meanwhile a note upon the "brain and skull" of *Amphioxus*. By reason of the supposed absence of renal organs, and of any proper skull and brain, Agassiz was led to separate the lancelet from all other fishes; and Haeckel, going farther, made a distinct division of the Vertebrata (*Acrania*) for its reception; while Semper, in a lately published paper, separates it entirely from the vertebrates. Huxley now describes what he believes to be the representative of the ducts of the Wolffian bodies, or "primordial kidneys" of the higher vertebrates, in *Amphioxus*, and he also endeavors to point out that, although *Amphioxus* has no completely differentiated brain or skull, "yet it possesses very well-marked and relatively large divisions of the cerebro-spinal nervous axis and of the spinal column, which answer to the encephalon (brain) and the cranium of the higher Vertebrata." Professor Ray Lankester also contributes an important paper on the anatomy and embryology of *Amphioxus* as compared with the higher fishes.

Some important notes on the grayling of North America, by James W. Milner, and on the natural history of the *gourami*, by Dr. T. Gill, are contained in the report of the United States Commissioner of Fish and Fisheries.

Some new fossil fishes from the Devonian and carboniferous rocks of Ohio have been described by Professor J. S. Newberry. Of these the most important discovery was nearly the entire skeleton of *Dinichthys Terrellii*, the largest of all the old armor-plated Ganoids. In another species (*D. Hertzeri*), the maxillaries and mandibles are set with teeth instead of being sharp-edged. Professor B. G. Wilder also presented a paper to the American Association for the Advancement of Science, entitled "Notes on the American Ganoids" (*Amia*, *Lepidosteus*, *Acipenser*, and *Polyodon*).

A revised list of the fishes of Greenland, by Dr. Lütken, is given in the appendix to the English "Arctic Manual."

The habits of the pine snake, by Rev. S. Lockwood, are described in the *American Naturalist*. A new species of serpent, belonging to an undescribed genus, collected by Lieutenant Wheeler's expedition in Arizona, has been described by Professor Cope under the name of *Monopoma rufipunctatum*. The rostral shield of this new genus resembles that of *Phimothyra*, and the lateral head-shields those of *Cyclophis æstivus*. It is, however, more like *Eutænia*, the common garter-snake, in general character.

It is asserted by M. Gaudry that true-tailed Batrachians, with affinities to the modern Salamanders, existed in Permian rocks in France. Interesting discoveries of fossil *Batrachia* in the coal-measures of Ohio have been brought out by the geological survey of that state under the direction of Professor Newberry. The number of extinct forms have been thus increased to thirty-three. Professor Cope, who has studied the material, describes a new genus and species under the name of *Pleuropteryx clavatus*. It is remarkable for the structure of its ribs. Each of these presents a wide, thin ala on its posterior face, which is abruptly discontinued below. The shaft of the rib is short, and enlarged distally where it is hollow and truncate. The vertebræ are as large as those of the anaconda. Another genus exhibits two strata of chevrons in an armature of ventral rods, the angle of the upper having an opposite direction to that of the lower. The gular scutæ are smooth. It was named *Hyphasma lævis*. An interesting addition to the fauna was stated to be a new species of the horned genus *Ceraterpeton* of Huxley. The head is relatively large, and covered with reticulate ridges separated by rows of impressed dots. The horns are long, stout, and incurved. It is called *C. puncto-lineatum*.

In the course of some remarks on the Batrachians and Reptiles of Florida, Professor Cope stated that this state formed a distinct subdivision of the Austro-Riparian region (see Gray's Atlas of the United States, 1873, for a review of the geographical distribution), the evidence furnished by the lower vertebrates confirming that derived from the higher vertebrata and the plants. There are fifteen species of Batrachia and Reptilia not found in any other part of North America; three of these occur in Cuba, but none elsewhere. He states that Mr. Meek had recently sent to the museum of the Smithsonian Institution an *Elaps distans*—a poisonous snake—which had been known previously from the Sonoran region only. This discovery may be associated with that of the Western burrowing owl in Florida, and the fact that the Floridan *Ophibolus getulus* presents the same number of rows of scales as the black and white *Ophiboli* of the Sonoran region.

The first fossils found (by Professor Cope while attached to Wheeler's survey) in the "trias" of the Rocky Mountains are those of fishes and reptiles. The fishes are represented by scales of small species, which are abundant in the coprolites of the reptiles; the latter represent the three orders of *Crocodiles*, *Dinosauria*, and apparently of *Sauropterygia*. The dinosaurian order is represented by a part of the crown of a tooth of a species of large size, of the general character of *Lælaps*. Both faces are convex, the one more so than the other, and the long axis of the crown is curved toward the less convex side. Both cutting-edges are sharply and closely crenate denticulate, as in *Lælaps*, *Aublysodon*, etc.; otherwise the enamel is perfectly smooth.

The structure of the central nervous system of the turtles and of the axolotl has been elucidated by Dr. Stieda in Siebold and Kölliker's *Zeitschrift*.

The *Crocodilia* are divided by Professor Huxley into three sub-orders, as follows: 1. *Parasuchia*, containing the genera *Stagonolepis* and *Belodon;* 2. *Mesosuchia*, with the genera *Steneosaurus*, *Pelagosaurus*, *Teleosaurus*, *Teleidosaurus*, *Metriorhynchus* (*Goniopholis? Pholidosaurus?*); 3. *Eusuchia* (*Thoracosaurus*, *Holops*, and recent forms).

In last year's *Record* we announced the discovery of the crocodile by the late Professor Wyman in Florida. During the past year M. Hornaday has published an article on this animal in the *American Naturalist*, with figures of the head and skull. A large male measured fourteen feet in length; its mate, a female, ten feet eight inches. It is regarded by the author as a new species, for which he proposes the name *Crocodilus Floridanus*.

Another link in the chain of evidence showing the affinities of the birds with the reptiles—a subject engrossing the attention of comparative anatomists—is afforded by fresh studies by Professor Morse on the "intermedium" bone of birds. Last year he found this bone in the tern. During the present year he ascertained the presence of this bone in the petrel, sea-pigeon, and eider-duck. This additional evidence showed beyond question the existence of four tarsal bones in birds, as well as four carpal ones. In making these investigations he had also discovered embryo claws on two of the fingers of the wing—the index and middle finger. Heretofore in the adult bird a single claw only had occurred in a few species, such as the Syrian blackbird, spur-winged goose, knob-winged dove, jacana, mound bird, and a few others, and in these cases it occurred either on the index or middle finger, or on the radial side of the metacarpus. All these facts, he claims, lend additional proof of the reptilian affinities of birds.

By far the most important discovery proving the reptilian affinities of birds was the discovery in 1872, by Professor Marsh, of birds with veritable teeth in sockets in the jaws, much as in reptiles. Professor Marsh now fully describes and figures these bird-skulls and teeth, and proposes the term *Odontornithes* for the new sub-class, with two orders: *Ich-*

thyornithes (with the genera *Ichthyornis* and *Apatornis*) and *Odontolcæ*, containing the genus *Hesperornis*. In comparing the two genera, *Ichthyornis* and *Hesperornis*, the author calls attention to the remarkable combinations of characters in each genus. The former has teeth in distinct sockets, with biconcave vertebræ; while the latter has teeth in grooves, and yet has vertebræ similar to those of modern birds. They all occurred in the upper cretaceous beds of New Jersey and Kansas. The remains preserved of *Hesperornis regalis* show that this species was larger than any known aquatic bird, the length from the apex of the bill to the end of the toes being between five and six feet. The rudimentary wings prove that flight was impossible, while the powerful swimming legs and feet were peculiarly adapted to rapid motion through the water. The tail appears to have been much expanded horizontally, as in the beaver, and doubtless was an efficient aid in diving, perhaps compensating in part for want of wings, which the penguins use with so much effect in swimming under water. That *Hesperornis* was carnivorous is clearly proved by its teeth, and its food was probably fishes.

The coloring matter of the shell of the eggs of birds has been studied by Mr. Sorby with the solar spectroscope. He finds that their different tints are due to a variable mixture of seven well-marked coloring matters. Hitherto the greater part of these had not been found elsewhere. The principal red coloring matter was connected with the hæmoglobin of blood, and the two blue coloring matters were probably related to bile pigments; but in both cases it was only a chemical and physical relationship, and the individual substances were quite distinct, and it seemed as though they were special secretions. There appears to be no simple connection between the production of these various egg-pigments and the general organization of the birds, unless it were in the case of the *Tinamous*, in the shells of the eggs of many species of which occurs an orange-red substance not met with in any other eggs, unless it were in those of some species of cassowary.

A fossil bird belonging to the Vultures has been discovered by Professor Cope, and named *Vultur umbrosus*. It was about as large as the "king vulture" (*Cathartes papa*) of Mexico. The true vultures do not exist at present in the Western hemisphere, and the present determination adds one more Old World type to the extinct fauna of the United States. The genus *Vultur* is now associated in Africa and India with *Rhinoceros*, camels, horses, etc., as in the period of the late tertiary in New Mexico.

A new work on the locomotive apparatus of birds, by M. Alix, contains a careful study of the skeleton and muscular system.

The subject of instinct in birds and mammals has again been discussed by Mr. Spalding in *Nature*. He claims that the instincts of animals appear and disappear in such seasonable correspondence with their own wants and the wants of their offspring as to be a standing subject of wonder. They have by no means the fixed and unalterable character by which some would distinguish them from the higher faculties of the human race. It is a common practice to hatch duck's eggs under a hen, though in such cases the hen has to sit a week longer than on her own eggs. Mr. Spalding tried an experiment to ascertain how far the time of setting could be interfered with in the opposite direction. Two hens became broody on the same day, and he set them on dummies. On the third day he put two chicks a day old to one of the hens. She pecked at them once or twice, seemed rather fidgety, then took to them, called them to her, and entered on all the cares of a mother. The other hen was similarly tried, but with a very different result. She pecked at the chickens viciously, and both that day and the next stubbornly refused to have any thing to do with them. Birds, he maintains, do not *learn* to fly. On shutting up five unfledged swallows, they flew when liberated as well as the old ones. Such he found to be the case with titmice, tomtits, and wrens. With man, as in the lower animals, Spalding believes that the progress of the infant is but the unfolding of inherited powers. "With wings there comes to the bird the power to use them; and why should we believe that because the human infant is born without teeth, it should, when they do make their appearance, have to discover their use by a series of happy accidents?" In common with other evolutionists, Spalding believes that "instinct in the present generation may be regarded as the product of the accumulated experiences of past generations."

A specimen of an almost complete Solitaire (*Pezophaps solitarius*) was found, with a second, in the island of Rodriguez by Mr. J. Caldwells. These specimens, together with that procured by Mr. Slater, one of the naturalists of the Venus Transit Expedition, will settle some points in the osteology of the peculiar extinct Columbine birds, of which so many separate bones have been obtained.

New light has been thrown on the mode of occurrence in New Zealand of the bones of the moa (*Dinornis*) by Dr. Hector. He demonstrates most conclusively, according to *Nature*, that the Maoris told the Europeans of their existence. He believed that there was no hope of ever finding the birds alive, for he had been over the whole of the islands very thoroughly without seeing them. He thought that these gigantic birds lived in the open and low scrub, in which they could walk, not among the forests. In all this region, within his own memory, the moa bones were extremely abundant in the South Island, all over the ground. In the enormous extent of subalpine country in the South Island, which was covered by only a light vegetation, large quantities of well-preserved moa remains have been recently found, associated with the remains of the natives. It appeared to him that the natives had pressed up the country for the purpose of capturing, killing, and eating the moas; and as the natives could not follow them through the sharp bayonet-grass and other underscrub, they drove them together and destroyed them by fire. Moa remains also occur in caves, turbary deposits, and dried-up swamps; the bones got out of a swamp remains indicating at least 1700 individuals. He did not think that moa bones occur in the tertiary deposits, but a true bird-bone, which had been found in such deposits in New Zealand, he was inclined to think belonged to a gigantic extinct penguin. A new contribution to the anatomy of the gigantic birds of New Zealand, by Professor Owen, in the Transactions of the Zoological Society, contains a restoration of the skeleton of *Cnemiornis calcitrans*. It was a goose-like bird as large as a cassowary. Those gigantic birds, the cassowaries, are found to be more numerous in species than formerly supposed. A short time ago but one cassowary was recognized by naturalists. Recent expeditions into the less-known portions of New Guinea and adjoining islands have furnished nine forms in all, of which six are said by Mr. Sclater to be now living in the Gardens of the Zoological Society of London. Mr. Sclater gives in *Nature* a brief synoptical table of the genus. The memoir in full, with colored illustrations, appears in the Transactions of the Zoological Society of London.

Some notes on birds which have been found in Greenland are communicated to the *Ibis* by Professor Newton. They will prove of much interest to American ornithologists. A new wren has been found in Florida by Mr. C. J. Maynard, which is described by Mr. Ridgway in the *American Naturalist* under the name of *Thryothorus Ludovicianus.* In coloration this strongly marked form closely resembles *T. Berlandieri* of the lower Rio Grande, but its size is much greater than even the most northern examples of *Ludovicianus* proper, while *Berlandieri* is smaller. Says Mr. Ridgway, "It is very remarkable that the southern form of this bird should be so much larger than the northern one, in direct opposition to a recognized law of climatic variation; but we have another case of this same exception to the rule in *Catherpes Mexicanus*, and its northern race, *var. conspersus.*" These examples probably justify the suggestion made by Ridgway that an exception to the rule of decrease in size to the southward, in resident species, may be made in case of families or groups of families, which have in temperate latitudes only outlying genera or species, the increase in this case being to the southward, or toward the region in which the family or group is most highly developed.

Comparative and detailed descriptions of *Nisus Cooperi* and *N. Gundlachi* are offered by Mr. Ridgway, who also publishes in the Proceedings of the Academy of Natural Sciences of Philadelphia a monographic account of the Buteonine subgenus *Craxirex.*

A list of the birds of the Philippine Islands, numbering ninety-six species, and greatly extending our knowledge of the birds of the East Indies, is contributed by Viscount Walden to the Transactions of the Zoological Society of London. It is illustrated by eleven plates.

Some unpublished drawings of the Dodo and other extinct birds of Mauritius were exhibited by Professor Newton at a meeting of the Zoological Society of London. They are contained in the original manuscript of a journal kept during the voyage of a Dutchman to Mauritius in 1601–1602. Among the birds also represented were *Aphanapteryx brœcki* and *Psittacus mauritianus.* The figures of the Dodo, rough as they are, "must have been drawn by no ordinary hand, and evidently from the life. The various attitudes in which the bird is represented certainly assist us in forming a conception of what it must have been like."

Notes on *Falco labradorus* and other species, by H. G. Dresser; on Peruvian birds by Mr. Sclater, and other papers, anatomical and descriptive, by Rowley, Ganod, Mivart, Sharpe, Whiteley, Layard, Salvin, Sclater, and others, occur in the Proceedings of the Zoological Society.

Contributions to the anatomy of the mammals are contained in an elaborate memoir on the Daman by M. George, published with a number of plates in the *Annales des Sciences Naturelles.* Professor W. S. Barnard has compared the muscles of man with those of the higher apes, showing the points of similarity as well as of difference. A point made in this paper was the statement that one of the buttock muscles supposed to be peculiar to the higher apes, distinguishing them from man, really existed in the human body, and in a similar position. It was shown that the muscle thus described by Traill, and afterward by Wilder, as existing in the chimpanzee, and by Owen and Bischoff in the orang, and by Coues in the opossum, is also found in man, and offers no distinction in this respect. His investigations tend to prove that all the muscles possessed by man can be traced backward in the lower form of animals, through the apes to the lemuroids.

The indications of descent exhibited by North American Tertiary mammals have been shown by Professor Cope in the gradual development from one form to another by changes in the foot bones through a long series, beginning with the extinct Tertiary mammals, and ending with those of the present day. A similar process of change was traced in the teeth of animals, the simpler forms of teeth in the Eocene formation being a crown with four tubercles. The human skeleton, he declares, retains many more ancient types than other mammalia.

The extensive and very fully illustrated work by Professor Cope, entitled "The Vertebrata of the Cretaceous Formations of the West," published in the Reports of Hayden's United States Geological Survey of the Territories, is replete with new data regarding the wonderful fauna which inhabited the ancient lakes of the far West. After giving in an introduction his views on the significance of paleontological science, he divides the work into three parts. The first part is devoted to the classification and distribution of the Cretaceous deposits of the West; the second part contains descriptions of the Cretaceous Vertebrata of the West; while the third part is occupied with a synopsis of the known Cretaceous Vertebrata of North America. The work is illustrated with fifty-seven lithographic plates.

It has been stated, says Cope in this work, that the life of the present period in the Southern hemisphere is not homogeneous. The same is true, though in a less degree, of the Northern. Thus, if we include India in the latter, the elephant is a Pliocene form, and the true rhinoceros Upper Miocene. In the Northern hemisphere the dogs are Miocene. In North America, the opossum, and probably the raccoon, are Eocene; the wolves and foxes appeared in the Miocene age, and the weasels in the Pliocene. Perhaps the cats first appeared in the American Pliocene. Comparatively few mammalian types mark, by their origin, the latest geologic epochs. Such are the ruminants, as deer and oxen, with the true horses, which all commence in the Upper Pliocene of the Northern hemisphere. Finally, man alone signalizes the last or glacial period, and is to reach his culmination in the ages that intervene between that great time-boundary and one to come. Thus a certain proportion only of the life of a given epoch is characteristic of it—that is, originates in it; the remaining members being legacies from preceding ages. Hence the latest forms of life embraced in an extinct fauna are the true indicators of the chronological relations of that fauna. The total number of North American Cretaceous Vertebrates enumerated and described is 253, of which 97 are fishes, 147 reptiles, and 9 are birds. No mammals have yet been discovered.

Whether thoroughbred stock of old and well-established herds ever reverts to the original type is called in question by Professor Brewer, as he asserts that there is no proof of this "dogma." He thinks that the practical breeders of thoroughbred stock (of whatever kind) commonly believe that so long as the breed is kept pure and no other blood mingled, that, although the animals may vary greatly in excellence, all of them will have the essential characters which distinguish that breed from all other breeds or "types." On the other hand, many persons (not breeders of thoroughbred stock so far as he knows) have asserted that, if neglected, any breed will "revert to the original type." That *grade* animals often "revert," that curious freaks and sports often attend violent crossing (and also that breeds *deteriorate* under bad management or bad conditions), are well enough known; but these facts do not affect the specific questions asked (in a printed circular), where *the blood is supposed to have been kept strictly pure.*

The address of Mr. Sclater before the section of Biology of the British Association for the Advancement of Science was on "The Present State of our Knowledge of Geographical Zoology." It was restricted to the Vertebrates, but is a useful discourse.

"Bats and their Young" is the title of an article by Professor B. G. Wilder in the *Popular Science Monthly*, and contains much new material regarding the early stages of these animals. He has also contributed to the *American Journal of Science* a description of a fœtal manatee.

Important monographic accounts of the *Saccomyidæ*—the group of Pouched Mice—and the *Geomyidæ*, or Gophers, have been published by Dr. Coues; while Mr. J. A. Allen has published in the Proceedings of the Boston Society of Natural History a synopsis of American *Leporidæ*, or Hares, the present paper being an abstract of a monograph now in preparation. Several papers on new or little-known mammals by different writers are contained in the Proceedings of the Zoological Society of London and other serials.

A new fossil *Lemur* has been described in the Proceedings of the Academy of Sciences of Philadelphia by Professor Cope, from the Eocene and Tertiary deposits of the Rocky Mountains. It belongs to a type which he had originally shown to have relations with the *Procyonidæ* and other related low forms of Carnivora. Professor Cope has also discovered in one of the Pliocene formations of the West a new species of dog of large size, which he calls *Canis ursinus*.

Professor Cope has discussed the phylogeny of the camels, based on several genera of fossil camels exclusively North American, as no well-determined form of this group has been found fossil in the Old World. Until such are discovered, there will be much ground for supposing that the camels of the Old World were derived from American ancestors; while the presence of the llamas in the existing South American fauna indicates the absence there of the conditions which caused their extermination from North America. A new species of *Mastodon* has also been described by Professor Cope, from New Mexico, discovered while he was attached to Wheeler's survey.

A gorilla, exported to Hamburg, where it soon died, has been preserved in spirits, and is to form the subject of a monograph by Dr. Bolau, by whom several important and doubtful points in the anatomy of the anthropoid apes may be settled.

The embryological history of man, as compared with other vertebrates, has been treated of in a popular work by Haeckel, entitled "Anthropogeny, or the Developmental History of Mankind." The work is being translated into English.

BOTANY.

Insectivorous Plants.—Three ways are now recognized by which plants entrap insects. First, as in *Dionæa muscipula*, or Venus's fly-trap, where the two blades of the leaf close rapidly together, and the cilia upon the edges interlock so as to imprison any insect which may happen to be inside; second, as in different species of Drosera, where the leaves are covered with hairs, at whose tips is a sticky exudation by which insects are caught; third, as in different species of Utricularia, where the leaves are furnished with small bladders, into which small insects crawl, but are prevented from leaving by a peculiar arrangement of hairs around the orifice. In Dionæa there are three highly sensitive hairs in the centre of the two lateral portions of the upper-part leaf, and the closing of the leaf takes place when insects or foreign bodies come in contact with these hairs. In addition to the highly sensitive hairs just mentioned, there are also glands on the upper surface of the leaf which secrete an acid juice by which the captured insects are digested. In Drosera, when any body has been caught by the sticky fluid at the end of a hair, an impulse is conveyed through the hair to those on other parts of the leaf, which causes them to bend over until they touch the object caught. They then secrete an acid juice by which it is digested. In Utricularia, the insects caught in the leaf-bladders slowly decompose. Darwin has made very careful investigations on the process of digestion in Drosera and Dionæa, and comes to the conclusion that the secreted fluid in both cases is closely allied to, if not identical with, the gastric juice. Although contact of almost any foreign body will cause, in one case, the hairs to bend over toward it, in the other the leaf itself to close suddenly, the digestive power of the secreted fluids in both cases is only capable of digesting nitrogenous substances. Salts of ammonia seem to have the greatest effect on the hairs of Drosera, and especially phosphate of ammonia, extremely minute quantities of which have a powerful effect. The leaves of both Drosera and Dionæa seem to be insensible to falling drops of rain and currents of air.

Distribution of Seeds.—At the request of M. Alphonse de Candolle, a number of experiments were made by M. G. Thuret, of Antibes, France, to ascertain how long different seeds and fruits would float on salt water. He concludes, contrary to the opinion of Martins, that distribution of plants by means of ocean currents can take place only to a very limited extent, as in by far the greater number of his experiments seeds and fruits sank either at once or in a few days. M. Thuret also experimented on the power of germination of seeds after continued immersion in salt water. Out of the seeds of thirty-three species, which were immersed for thirteen months, twenty-four were in good condition and were sown in pots. Of these twenty-four, ten grew.

Disease of Orange-trees.—The orange-trees of California have lately been attacked by the fungus *Capnodium Citri*, Berk. and Desm. The disease is recognized by the leaves being covered with a blackish powdery substance, which can without difficulty be wiped off. At the same time a disease attacked the olive-trees. The name given to the fungus in the latter case is *Antennaria elaiophila*. This is probably only a sterile form of the fungus found on the orange-trees. A similar disease also attacks the guava. The disease of the olives has been known for a long time in the south of France, but no remedy has been proposed. The disease of the orange is known to occur in several tropical countries.

Male and Female Organs in Agarics.—Almost simultaneously, the discovery of antheridia and carpogonia in species of Coprinus, a kind of toadstool growing on dung, has been announced by Professor Max Rees in his inaugural address at Erlangen, and by Professor P. Van Tieghem in the *Comptes Rendus;* and farther details have been given by E. Eidam in the *Botanische Zeitung.* Some of the spores of Coprinus germinate and produce tufts of antheridia, while others bear round cells with a slight projecting point, which are the carpogonia. The contact of the antherozoids with the carpogonia causes a change in the latter, which grow up into the visible stem and pileus of the Coprinus. This recalls the process of fertilization in the Ascomycetes.

Red Snow Plant.—The red snow plant (*Hæmatococcus*, or *Protococcus nivalis*) has been shown in a paper by Dr. Joseph Rostafinsky, published in the Memoirs of the Academy of Sciences of Cherbourg, to be identical with the common *Hæmatococcus pluvialis*, and the name applied by him to both is *Hæmatococcus lacustris.* The plant is propagated by zoospores, of which there are two kinds; but, in spite of the opinion of Velter, there is no copulation of zoospores in this case. The amount of cold which the zoospores of this plant will endure without apparent injury is something extraordinary. They have been known to be frozen solid, and yet recover on melting of the ice about them.

Effects of the same Temperature upon Plants of Different Latitudes.—It having been asserted that vegetation is more promptly acted upon by the rise of temperature in spring in higher than in lower latitudes, M. Alphonse de Candolle reported in the *Comptes Rendus* some experiments on the subject. Seeds of three or four different annuals were sent from Northern and Southern Europe to Geneva. In one of the species the northern seed developed first. Again, branches of poplar, tulip-tree, and catalpa were sent from Montpellier to Geneva, and paired with similar branches taken from trees at Geneva. Both sets of branches were then placed in a cold room until they were penetrated by the same temperature, and then placed in glasses of water and removed to a warm room. The result was that the branches from trees growing at Geneva leafed out earlier by from eighteen to twenty-three days than those brought from Montpellier. M. De Candolle assigns two reasons for this precocity. First, he thinks that there has been a natural selection of the buds. The buds of a tree are in a continual struggle. The later, like the badly placed ones, develop imperfect branches, which are often stifled. The most precocious prevail, unless indeed they suffer from frost. In this way comes a selection, and a successive adaptation of the tree to the climate. How far this selection applies is a little doubtful, for the precocity is as likely to be disadvantageous as advantageous in a northern climate. The cause of the difference in the vegetation of northern and southern individuals is probably the more complete hibernal repose of the former, rendering them more susceptible to the heat of spring.

Potato Rot.—The oospores of the fungus which causes the potato rot (*Peronospora infestans*) have been discovered by Mr. Worthington Smith, of England. They are found in the substance of the potato leaves, where they form black spots. They occur more frequently in the leaves of American varieties of potatoes than in others. The fungus was at first supposed to be a Protomyces; but Mr. Smith, by macerating the leaves, found bodies similar to those described by De Bary as the oospores of species of Peronosporæ. As a practical result of this discovery, farmers need have no fear of planting potatoes after grain or clover, against which they had been warned, as the rot is not propagated by these crops. Also the stems and leaves of infected plants should be removed as soon as possible. The potato rot made its appearance in California, for the first time it is believed, in the month of May last, at least two months earlier than its usual appearance in the Middle and New England States.

Plum-Pockets.—The curious disease known in Germany as Pflaumen Narren, or Taschen, was observed near Boston in the month of June. The disease is caused by a fungus, *Ascomyces Pruni*, which distorts the young plums, making them appear at first swollen and then wrinkled. On cutting the fruit open it is found to be hollow. The disease is not uncommon in Germany, and has been reported in New Brunswick. The fungus is closely related to *Ascomyces deformans*, which attacks peach leaves, making them curl up.

Diseases of Forest Trees.—In the *Wichtige Krankheiten der Waldbäume* Hartig gives an interesting account of some of the diseases of European forest trees. He mentions, among other fungi injurious to coniferous trees, *Agaricus melleus*, and considers that the sclerotium form known as *Rhizomorpha subcorticalis* is nothing but a state of the mycelium of this species. It is curious to note how very large a proportion of fungi, recognized as injurious to forest trees, attack species of Coniferæ. According to the views of Hartig, not only are the different members of the order Uredineæ, as *Æcidium Pini*, Pers., *Cæoma pinitorquum*, A. Br., *Cæoma Laricis*, R. H'rtg., found injurious to coniferous trees, but also members of the orders Hymenomycetes and Ascomycetes. Of the former order, *Agaricus melleus*, L. *Trametes Pini*, Fr., and *Trametes raciperda*, R. H'rtg., are particularly mentioned as injurious to Coniferæ; but the former species, at least, also attacks other kinds of trees as well. Of the Ascomycetes attacking Coniferæ, *Peziza Willkommii*, R. H'rtg., is peculiar to the larch.

Club-foot in Turnips.—Farmers have long been familiar with a diseased form of turnip-roots in which they swell up and become very crooked and ill-shaped. This was supposed to be caused by the attacks of some insect, and, in fact, such roots when harvested are almost always found to be covered with insects. M. Woronin, of St. Petersburg, near which city the disease has just made its appearance, has investigated the subject, and comes to the conclusion that the trouble is caused by some vegetable organism, hitherto unknown, resembling in some respects the Myxomycetes, in others the Chytridineæ.

Growth of the Vegetable Cell.—Dr. Moritz Traube, at the meeting of German physicians and naturalists at Breslau, gave some account of experiments with artificial cells. When two colloid substances, which give precipitates with one another, are brought together in solution in such a way that a drop of one is introduced into a mass of the other, a pellicle is formed around the drop. Traube made use of a solution of tannic acid, into which he let fall a drop of a solution of glue. An artificial cell-wall was then formed around the drop, which gradually enlarged. Taking this as equivalent to a parenchymatous cell of a plant, Traube concludes that the wall of the cell arises by chemical precipitation, and that growth of the cell-wall is by intussusception. In the *Botanische Zeitung* for June 25, Reinke gives an account of some experiments which he thinks confirm Traube's view of the growth of the cell-membrane by intussusception.

The Schwendener Theory of Lichens.—The theory of the algo-fungological nature of lichens, first proposed by Schwendener, has many advocates and as many opponents. Among the advocates is M. Bornet, whose account of the gonidia of lichens appeared a year and a half ago in the *Annales des Sciences;* he has since published a second note on the subject, in which he mentions that he has seen cases of Opegrapha varia, Pers., in which the gonidia have produced the sporangia proper to Trentepohlia (Chroolepus Auct.). On the other hand, Dr. G. W. Körber gives the following reasons for his belief that the gonidia of lichens are not algæ: First, in true algæ the gonidia never produce hyphæ, while this is of common occurrence in the spores of lichens; second, that if the contrary were true, it is strange that in every lichen several types of algæ are necessary for the production of the lichen, and still more strange that in nature these various algæ occur without any further result; third, because many forms of gonidia are not known to algologists as such, because they have never been seen in a free state; fourth, because the lichen gonidia correspond in their forms only to those algæ which reproduce themselves by division, and not to those which propagate by sexual reproduction, the former process being only a physiological one common to many or all lower vegetable cells, and destitute of systematic value. The question is by no means settled as yet, for, although the advocates of the theory do not include many leading lichenologists (including under that term those who devote themselves exclusively to the determination and description of species of lichens), it does include the majority of the best vegetable histologists in Europe. It is often said that, were the theory true, the professional lichenologists would be the first to recognize it, as they have had a much larger experience than others. The contrary, however, seems to be the fact. The lichenologists, as the term is generally applied, look at the question from one side only. Their object is to describe and arrange large numbers of species, not to follow out the details of the development of any one. In classifying their species, the professional lichenologists have made use principally of the fruit, and paid but little attention to the gonidia. It is the presence of gonidia which, even according to the lichenologists, is characteristic of the lichen rather than the fruit, which is, as is admitted by every one, precisely similar to that of the ascomycetous fungi. The structure of the gonidia and their development has been vastly better made out by Schwendener and Bornet than by any of the lichenologists proper, who, instead of giving good figures and accurate descriptions of the growth of the gonidia from the hyphæ, which they maintain takes place, are satisfied with the mere statement that some one or other, not noted for his skill at the microscope, has seen, or thinks he has seen, this growth. If such an organic union between the hyphæ and gonidia exists, certainly skillful microscopists, whether lichenologists or not, ought to be able to see it. But such is not the case. If the Schwendener theory is not tenable, the only feasible theory is that of Professor Theodore Fries, who believes lichens are bodies consisting of hyphæ, or threads, and gonidia, and that the latter can exist without the former, and when found free have been erroneously considered algæ by some botanists; that is to say, the Oscillarieæ, the Palmelleæ, and other groups of algæ, are not really algæ at all, but gonidia of some lichen which have escaped and are living free. This view might be considered the true one were the gonidia of lichens limited to such forms as Oscillaria, Rivularia, and Palmella, whose method of reproduction differs somewhat from that of plants which are universally recognized as algæ. But in the genus Opegrapha the gonidia correspond in appearance to a genus of algæ known as Chroolepus, and M. Bornet has shown that they are propagated in the same way. Now Chroolepus is nearly related to Cladophora, and many other genera of undoubted algæ; and if we suppose that Chroolepus is nothing but an escaped form of lichen-gonidia, we must make the same supposition with regard to Cladophora, Chætomorpha, and other genera which live in both salt and fresh water, and have never been found united with any hyphæ. Such a supposition is, of course, entirely out of the question.

Copulation of Zoospores.—Professor J. E. Areschoug, of Upsala, has observed the conjugation of zoospores in *Dictyosiphon hippuroides*, Lyngb. This is the first member of the large group of Phæosporæ, which includes such large plants as the devil's apron of the east coast and the great kelp of California, as well as a multitude of minute filamentous species in which any sexual process has been discovered. Professors Areschoug, Pringsheim, and others, have already reported several cases of conjugation of zoospores in the Zoosporæ, which resemble the Phæosporæ as far as their zoöspores are concerned.

Marine Algæ of the United States.—Dr. E. Palmer has made some interesting additions to the United States marine flora during his stay at Key West. He found growing abundantly *Sargassum dentifolium*, previously known only in the Red Sea, and therefore not to be looked for in the United States; also a single specimen of a Polyphysa, an Australian genus. At Nassau he found *Cystoseira myrica*, also of the Red Sea, the first member of the genus reported on the east coast of North America. Dr. Palmer has also made collections of rare and interesting plants on the island of Guadalupe, off the west coast. *Sargassum piluliferum*, of the coast of Japan, was found by him there. Nearly all the species recently added to the California marine flora have been species occurring in Chili and the southwestern coast of South America, with a few species common to the Cape of Good Hope and to Spain and Portugal. The latest collections seem to indicate a great uniformity of species of the west coast of America from Vancouver's Island to Patagonia, branching off into distinct arctic and antarctic floras.

New Classification of Thallogens.—In the fourth edition of Sachs's "Lehrbuch der Botanik" a new classification of Thallogens is given, which, with some modifications, is likely to be generally adopted at no very distant date. The division of Thallogens into lichens, fungi, and algæ has been the basis of all works on cryptogamic botany for many years. The distinctions between these three groups are as follows: Algæ contain chlorophyl, grow in water or very wet places, and are epiphytic, never parasitic; fungi are without chlorophyl, grow in the air, very rarely submerged, and are parasitic; lichens are composite plants, having fruit similar to fungi and thalli, which are composed of hyphæ, or threads, in which are various-shaped alga-like bodies called gonidia. Sachs does away with these three divisions, and divides all the Thallogens into two parallel groups—one in which the members contain chlorophyl, the other in which they are destitute of it. There has long been observed a parallelism between certain groups of fungi and algæ, as between the Conjugatæ of the algæ and the Mucorini of the fungi. Sachs brings such parallel groups together, and divides each group into two portions, in one of which the plants contain chlorophyl, in the other of which they do not. Sachs's scheme is as follows:

THALLOGENS.

First Class.

PROTOPHYTES.

Containing Chlorophyl.	*Without Chlorophyl.*
Cyanophyceæ.	Schizomycetes.
Palmelleæ (in part).	Saccharomyces.

Second Class.

ZYGOSPORÆ.

Containing Chlorophyl.	*Without Chlorophyl.*
Conjugation of Moving Cells.	
Volvocineæ.	Myxomycetes.
(Hydrodictyeæ.)	
Conjugation of Stationary Cells.	
Conjugateæ (incl. Diatomes).	Zygomycetes.

Third Class.

OOSPORÆ.

Containing Chlorophyl.	*Without Chlorophyl.*
Sphæroplea.	Saprolegniaceæ.
Vaucheria.	Peronosporeæ.
Œdogonieæ.	
Fucaceæ.	

Fourth Class.

CARPOSPORÆ.

Containing Chlorophyl.	*Without Chlorophyl.*
Coleochæteæ.	Ascomycetes.
Florideæ.	Æcidiomycetes.
Characeæ.	Basidiomycetes.

Sachs regards the presence or absence of chlorophyl as a physiological, not a structural character, and consequently not to be taken into consideration in dividing the Thallogens into classes. The Protophytes, as defined by Sachs, constitute a group of which we know but very little, and future studies may prove that it is not sufficiently well characterized. In the present state of our knowledge, however, Sachs's group of Protophytes is as good as any. The class of Oosporæ is a very natural one; but the same can not be said of the Carposporæ, which, although in the main well characterized, include plants whose position in that order is, to say the least, doubtful.

Attar of Roses.—The Attar of Roses of commerce comes almost entirely from Roumelia, on the southern side of the Balkan Mountains. It is obtained from the flowers of *Rosa damascæna*, and, according to Mr. Baker, of Kew Gardens, ranges from France to Asia Minor.

Flora of Guadalupe.—The island of Guadalupe, off the coast of California, has recently been visited by Dr. Edward Palmer, and a report on the Phænogamous plants and higher cryptogams collected by him was made by Mr. Sereno Watson, of Cambridge, to the American Academy of Arts and Sciences, November 10th. The island is in latitude 29° north, about 220 miles from San Diego. It is only 25 miles long by 10 broad, and its highest point is 3900 feet above the level of the sea, yet the vegetation of the southern and eastern portions of the island attains its perfection full two months before that of the rest of the island. It has probably never been inhabited until within a few years, yet goats have already begun to produce a disastrous effect upon the native flora of the island. The number of species of higher plants collected by Dr. Palmer was 133, distributed as follows: 102 exogens, 8 endogens, 21 vascular cryptogams, and 2 undetermined plants. With regard to the flora, Mr. Watson says: "Looking at the relative proportion which the large orders bear to each other in this limited flora as compared with the flora of Great Britain, which is the only similar one of which we have the data for comparison, we find that the proportions which the Compositæ and Leguminosæ bear to the whole are identical in both, 77 per cent.; while in the next largest orders, Cruciferæ, Scrophulariaceæ, and Gramineæ, the proportions are very close. A marked discrepancy is shown in the almost entire absence in Guadalupe of Cyperaceæ, Blygonaceæ, Rosaceæ, and Liliaceæ. The more common plants of the island are *Erodium cicretarium*, a common weed of Europe, a pine common to Southern California, a juniper common in California, a cypress similar to a Mexican species, a small oak common throughout California, and a palm, 40 feet high, whose fruit is edible. The vegetation of this island is not a derived one from California or any other region by any process of conveyance or selection, but it is an integral part of the flora of California, contributing beyond its measure toward the completion of that flora, and giving some hints as to the close connection that may, at some time, have existed between it and others more remote."

AGRICULTURE AND RURAL ECONOMY.

A *résumé* of progress in Agricultural Science would properly include, first of all, a reference to the Agricultural Experiment Stations, since it is in these institutions that by far the largest part of the research in this branch of science is carried on.

It is in Europe, and especially in Germany, that the experiment stations are most fostered. There are at this date some forty experiment stations proper in active operation within the limits of the German Empire, and twenty-two in other European countries. Besides these, there are between twenty-five and thirty laboratories and other establishments supported by schools, societies, or private individuals, and devoted to researches in agricultural science.

But one or two new experiment stations have been actually established in Europe since our last annual report. Four more have, however, been projected, and we shall doubtless hear of their actual establishment, as we have of the organization of some projected during previous years. Among the latter, by the way, is the one in Alsace-Lorraine, the province lately acquired from France by Germany. It is worthy of note that among the means adopted by Bismarck to reconcile and improve this new territory have been the establishment of a university at Strasburg and an experiment station at Rufach.

In the United States some hopeful beginnings have been made in this direction. The Bussey Institution of Harvard

University, though not an experiment station in name, is, under the direction of Professor Storer, proving itself to be one in fact. The movement toward the establishment of an experiment station in Connecticut, which was commenced two years ago, has resulted in the organization of a station at Middletown, in connection with the Wesleyan University, and under the direction of Professor Atwater.

Turning now to researches in agricultural chemistry, we notice that Knop has continued the series of studies on the absorptive power of soils in which he has been engaged for several years. His later results accord with his previous ones in indicating that the absorption of ammonia and potash increases with the amounts of three separate factors, "sesquioxide silicates" (of alumina and iron), "released silicates" (products of weathering), and sesquioxide of iron. These results are confirmed by investigations of Seiler and Frey. The same subject has also been investigated by Pillitz and Eichhorn. The latter chemist has tested the effect of zeolitic minerals in the soil upon the absorption of ammonia and potash. His experiments accord with the view for some time held that these hydrated silicates are most efficient factors of such absorption. The near relation of these to Knop's "released silicates" shows that the views of Eichhorn and Knop are not widely divergent. It should be added that the efficiency of sesquioxide of iron in absorption of alkalies is probably less than Knop has formerly supposed.

Fittbogen has studied the effects of various chemicals on nitrification in peat. He found the formation of nitric acid to be favored by carbonates of potash and lime, by lime, and by magnesia, and to be retarded by sulphuric acid, sulphate of lime, and sand. The formation of ammonia was greatest in confined air without chemicals, and was hindered by the above compounds.

Simon claims to have shown that humic acid absorbs nitrogen from the air with the formation of humate of ammonia, which is soluble in water. In this view peat and muck would be valuable, not merely as amendments and for the fertilizing material they contain, but also as purveyors of atmospheric nitrogen to the soil.

Storer has published some most valuable investigations

"On the Importance as Plant-food of the Nitrogen of the Soil," which enforce and, in part, explain the fact that the nitrogen of vegetable mould—the organic nitrogen of the soil—is under certain conditions available as food for plants.

Storer has also conducted a very interesting and important series of field experiments on the effects of different fertilizers on a soil which may be taken as a type of the light soils overlying gravelly drift that are common in New England. Potash proved more efficient than phosphoric acid or nitrogen, thus showing that the land stood most in need of potash. Indeed, in some cases, in this naturally sterile soil, phosphoric acid proved actually injurious to crops. Storer thinks this ill effect is due to the inability of the young seedling to endure excess of phosphoric acid in absence of needful supplies of other plant-food, and suggests as a new reason the higher value of superphosphates, that the soluble phosphoric acid is more uniformly diffused through the soil, so that no hurtful excess can come in contact with the roots of the plant.

A number of cases of poisoning of crops by ammonium sulphocyanate are reported in Europe. This compound sometimes occurs in the ammonia salts which are made at gas-works and used for fertilizers. It is recommended to test all fertilizers which may contain these salts for ammonium sulphocyanate.

That the subject of fertilizer analysis is receiving increased attention in this country is evinced by the reports of the chemists of Boards of Agriculture and of inspectors of fertilizers of various states. The reports of Professor Johnson, of Connecticut, Professor Goessmann, of Massachusetts, and of the inspectors of fertilizers of some of the Southern States, contain much timely information, and are exerting a great and salutary influence upon the trade in fertilizers.

Under the head of Vegetable Physiology, we note some very interesting water-culture experiments, by Fittbogen, on the quantity of nitrogen needful as food for the maximum development of the oat plant, which show the relation between the amount of nitrogen supplied and the yield of straw and seed, and accord with the results of other observations in showing that lack of nitrogen diminishes not only the whole crop, but also its percentage of nitrogen, and that the straw in this case suffers more than the seed. We have space for only the briefest reference to the interesting studies of Lehmann on the compounds of nitrogen best adapted to the nutrition of plants; by Schloessing on the absorption of ammonia by plants; by Bretschneider and others on the nutrition of sugar-beets; by Mayer and Wolkoff on the respiration of plants; and by Fittbogen on the evaporation of water from the oat plant.

The subject of the nutrition of domestic animals, or, to speak more generally, that of animal physiology, has been actively studied during the past year by feeding experiments in the experiment stations and elsewhere.

Among the more important investigations published are those of Wolff, Stohmann, Kühn, Märcker, Schulze, Fleischer, Hoffmeister, Heiden, Voit, Weiske, Wildt, and Pott.

Among the subjects investigated have been the digestion of different foods by different animals; the effect of fodder on milk production, the functions of the ingredients of foods, as the albuminoids, carbohydrates, and fats, in the formation of flesh and fat, and in the production of animal heat and muscular force.

The results of the year's work are not characterized so much by the discovery of new principles as by the confirmation and elucidation of those previously propounded.

For instance, one of the important principles brought out by the late German researches is that the carbo-hydrates, as starch and sugar, or easily digestible foods rich in these, as potatoes, when fed in considerable quantities with coarse foods, as hay and straw, decrease the digestion of the latter, while albuminoids or concentrated foods rich in these have no such effect. This is very strikingly exemplified in feeding experiments by Wolff, Märcker, Schulze, and Stohmann. So, likewise, the principle that a part of the woody fibre of plants, to wit, the cellulose, is digestible by ruminants and even horses is confirmed by several experiments of the same chemists.

The question from what ingredients of the food the fat in the body is made up is still hotly discussed, one main point in the controversy being whether the fat formed in the body, other than that coming from the fats in the food, is formed from albuminoids or carbo-hydrates. The general drift of opinion is away from the old theory of Liebig that the fats are formed from (carbo-hydrates) sugar and starch, and toward the view advanced by Voit that the albuminoids of the food are the sources of the fats in the body. This latter opinion is strengthened, though not confirmed, by late researches by Weiske and Wildt.

PISCICULTURE AND THE FISHERIES.

The Fisheries.—We are without the data necessary for a summary, or a general expression of the results of the fisheries of the world at large, for 1875; but for the United States we have to record that the shore and lake fisheries have furnished large yields; although, in view of the continued increase in the number of nets and in the force of men necessary to work them, it may be questioned whether there has not been an actual diminution in the supply of fish at certain points. It is a well-established fact that stations for taking the whitefish of the lakes are readily exhausted, and that given localities become poorer and poorer successively, until, in a comparatively few years, they very greatly decrease in value as fishing stations. In this connection the measures, to be described hereafter, for renewing the supply by artificial propagation are of the utmost importance.

The Atlantic shore fisheries, for such species as the scup, sea-bass, etc., have been poorer than usual; while the catch of shad, especially on the whole southern coast, as far east as the Chesapeake Bay, was much less than for many years past. On the contrary, farther east—in the Delaware, Hudson, and Connecticut—the number taken has been unusually large. The explanation of this is found, by some, in the occurrence of a very late spring, with a high, cold state of the water, which is thought to have deterred the fish from entering the southern rivers, and probably caused them to extend their migrations farther to the east.

The mackerel fishery for the year has also been inferior to that of the previous season, while that of the cod has been about as usual. The menhaden fishery, on the eastern coast, is now rapidly becoming one of the most important elements in this branch of industry, and was prosecuted with much vigor and with a very large yield. In 1874 three and a half million gallons of oil were made from 492,000,000 fish. The catch for 1875 was over 565,000,000, valued at $12,650,000.

Within the last few years large numbers of menhaden have been put up in tin cans, prepared in oil like sardines, and known by the various names of American sardines, ocean trout, shadines, etc., proving very palatable, even to those who are familiar with the oily, rank flavor of the fresh fish, and in many places replacing the sardines on account of their much cheaper price.

Some idea of the importance of the fisheries of the United States may be gathered from the statistics of the returns made to the port of Gloucester, Massachusetts, for 1875, the total catch amounting to 177,473 quintals of Bank cod-fish, 185,758 quintals of Georges cod-fish, nearly 10,000,000 lbs. of halibut, etc.; the total value amounting to $2,905,994. This does not include the product of the shore fishing.

Another illustration of the same kind is furnished by a table of the consumption of fish brought to the Washington market, as shown by the report of the fish inspector of that city. The whole number of fish inspected in 1875 amounted to a little over 7,000,000 lbs., principally shad, herring or alewives, and striped bass—nearly all having been taken in the Potomac River and Chesapeake Bay. This, it may be remarked, is a considerable diminution as compared with the yield of 1874, which amounted to nearly 11,000,000 lbs., the difference being due to the very much smaller number of shad and herring taken, as already referred to.

For many years past there has been a decline in the whale-fishery, the low price of oil, in consequence of the competition of petroleum, not warranting the outlay and expense. Partly in consequence of the exhaustion of the accumulated stocks of oil, the prices have recently improved, and many of the old vessels that had been laid up in New Bedford, Edgartown, and elsewhere, were refitted and sent out on voyages. From the "Annual Review" of the whale-fishery, for 1875, by Messrs. Bartlett & Sons, we learn that the number of vessels engaged January 1, 1876, is 169, against 163 on the 1st of January, 1875. The number of vessels at sea, January, 1876, is 137, to 119 in the beginning of 1875, showing, therefore, an addition to the fleet actually on the water of 18 vessels.

The average catch of the Right whale fleet amounted to 1384 barrels of oil, and 14,900 pounds of whalebone, being the largest catch for any year since 1850.

Sperm-whaling has been but moderately successful, the average catch being 333 barrels in the Indian Ocean, and 223 barrels in the North and South Atlantic. The constitution of the whaling fleet for 1876 is given as 77 vessels in the North and South Atlantic, 15 in the Indian Ocean and New Holland, 13 in New Zealand, 23 in the Pacific and Off Shore ground, 18 in the North Pacific, and 4 at Cumberland Inlet. The total receipt of oil in the United States in 1875 was 42,617 bbls. of sperm-oil, and 34,594 bbls. of whale-oil, with 372,302 lbs. of whalebone.

The average price of sperm-oil for 1875 was $1 60⅓ per gallon; of whale, 65½ cents; and of bone, $1 12¾ per pound. Of the fleet employed in the whale-fishery, by far the greater number of vessels came from the district of New Bedford, including New Bedford, Fair Haven, Dartmouth, Marion, and Westport, the aggregate being 125 vessels out of 169, just referred to.

The Newfoundland seal-fishery, which early in the season threatened to be almost a failure, improved somewhat later, and the average catch was perhaps equal to that of 1874. The great decrease of the catch in 1874 as compared with 1873 was a subject of much solicitude to the Newfoundland government, the same condition applying to the Greenland seal-fisheries also, and the enactment of some international measures has been very strongly urged for the protection of this interest. One cause of the rapid diminution appears to be due to the early date at which the pursuit is commenced, the mothers being killed by the sailors before the young are old enough to shift for themselves. As the two principal nations interested in this trade are Great Britain and Norway, negotiations have been in progress between them to fix upon a date before which it shall be unlawful to prosecute the business, the opening day proposed by Great Britain being the 5th to the 8th of April, while Norway insists upon the 1st of the month. It is thought that probably a compromise will be made on the 3d to the 5th.

The United States is but little interested in this question, having scarcely any participation in the catch on the Atlantic coast.

The fur-seal fisheries of the Pacific coast, restricted as they are by law, have been about the same as heretofore, the full complement of 100,000 having been taken by the Alaska Commercial Company on the islands of St. Paul and St. George, leased to the company by the United States. In addition to this number, it has been estimated that 10,000 are captured elsewhere on the coasts of South America and Siberia. The capture of seals in the Southern Pacific has been greater than usual, several large cargoes having been brought in from the Shetland Islands, South Georgia, etc., of very superior quality.

Fish-Culture.—This subject has received greatly increased attention during the year 1875, in consequence of the growing interest felt in stocking our rivers and lakes with new varieties of valuable food fishes, or in restoring others to depleted waters. Nearly all the states now have Commissioners for this purpose, and their action is to a certain extent concentrated and harmonized through the United States Fish Commission.

Since our last report several states have appointed such commissions for the first time; and the reports as published of the operations of the different commissions furnish a gratifying proof of energy and success in this direction.

The operations of the United States Fish Commission have been carried on on a much larger scale than in previous years, and bid fair very soon to make their impression upon the food supply of the country, the number of shad placed in public waters having amounted to nearly eleven millions, and of California salmon nearly nine millions. No distribution has yet been made of the eastern salmon, or of the land-locked salmon, although a large number of eggs of both have been obtained, as the proper time has not yet arrived. Several millions of eggs of whitefish of the lakes have also been obtained and hatched out.

An important forward step on the part of the Commission has been the importation of a large number of young carp from approved ponds in Germany. The want has long been felt of a fish that will thrive in the warmer waters of the United States, where trout and other similar kinds can not be sustained. In the carp we have a fish capable of withstanding any reasonable elevation of temperature, and one that, being a vegetable feeder, will find sustenance and grow rapidly in ponds and other limited bodies of water. Throughout Europe this fish occupies among the finny tribe the position of poultry among birds, and is almost as easily kept; and when the supply obtained by the United States Commission is large enough for distribution, there is no doubt that it will be eagerly sought for.

The State Commissions have also been doing their part in the multiplication of food fishes, the New York Commission, under the direction of the well-known Seth Green, having hatched out many millions of shad in the Hudson River, as also large numbers of brook and salmon trout. The efforts in the direction of multiplying black bass, pike, perch, etc., have also been continued.

Massachusetts has also continued the work of propagating shad in the Merrimac River. On the great lakes the multiplication of whitefish, has been conducted on a very extensive scale by several states, especially by Michigan. A special hatching-establishment has been erected at Detroit for the whitefish, and now contains about seven millions of eggs. A somewhat less number is also in process of development at the Canadian establishment on the opposite side of the river. Ohio has established several hatching-houses, and has a considerable number of whitefish and other species, to be distributed eventually to the waters of that state.

For information in regard to the minuter details of these various operations, reference may be had to the article on "Fisheries," page 465.

A good deal of the interest felt in the subject of fish-culture is due to the annual meetings of the American Fish-Culturists' Association, in New York, usually about the middle of February, where the several State Fish Commissioners and the principal fish-culturists of the country confer in regard to their mutual interests.

An annual convention of State Fish Commissioners is usually called by the United States Commissioner, when the general policy in regard to the kinds of fish to be specially treated on a large scale, and the most suitable places for their introduction are established. This meeting for 1875 was held in New York about the time of the annual meeting of the Fish-Culturists' Association, and that for 1876 will probably be called at Philadelphia some time during the period of the International Exposition.

INDUSTRIAL STATISTICS.

The condition of the *Iron* producing and manufacturing industries of the country, although presenting certain favorable features, is at the time we write much the same as at the close of the previous year. In attempting to present a statistical *résumé* of these important industries, we are confronted with the same difficulty to which we referred in our last; namely, the impossibility of securing accurate returns of yearly production until long after the close of the year; while estimates of probable production, owing to the magnitude of the industries, are more or less untrustworthy. The Statistical Report of the Secretary of the American Iron and Steel Association, just published, and containing detailed statistics of the American iron trade up to January 1st, 1875, will enable us to bring forward our figures of last year's *Record* to the date above named, and to replace our estimated values for the year 1874 with ascertained results. We are likewise able to supplement the association's statistics with certain facts in relation to the same subject, and which afford information of interest with regard to pig-iron production up to September 1st, 1875.

The figures published by the association are, for pig-iron, as follows: The total production of the year 1874 was 2,689,413 net tons, against 2,868,278 net tons in 1873, and 2,854,558 tons in 1872; showing a decrease of 178,865 net tons as compared with 1873, and of 165,145 tons as compared with 1872. Notwithstanding this decrease, the production of 1874 was much larger than was generally anticipated; much larger than the partial returns made to the association, and from which our estimated values, as published in last year's *Record*, were obtained, indicated.

This unexpected result the secretary explains by pointing to the fact that the extraordinary impulse given to the iron-producing industries of the country during the years immediately preceding the panic called into existence a large number of new furnaces, many of which were of the largest size and constructed upon the most approved plans. The furnaces which made 2,854,558 tons of iron in 1872 were mostly small, and, owing to the excitement and recklessness of those times, not so managed as to produce the best results. "When we consider," says the secretary, "that the lessened number of furnaces which made 2,868,278 tons in 1873 included all the large and improved new furnaces, and when we consider that there were almost as many furnaces in blast in 1874 as in 1873, that as a rule the best furnaces in the country were running in 1874, while the poorest stood idle, and that, from motives of enforced economy and by reason of increased skill, the management of most of the furnaces in blast in that year was such as to produce the largest possible yield, we need no longer wonder that the production of 1874 was only 178,865 tons less than the product of 1873." The number of new furnaces completed in 1874 was 38, against 50 in 1873, and 41 in 1872. No less than 46 stacks are reported as being in course of erection in 1875, while other new furnaces are projected. The district showing the greatest increase of production during 1874 was the miscellaneous coal and coke district of Ohio. The district showing the greatest decrease during 1874 was the Lehigh anthracite region of Pennsylvania. Utah Territory made her first pig-iron in 1874—200 tons of charcoal. After a long rest, Oregon, with one furnace, made 2500 tons of charcoal iron in 1874. Texas made 1012 tons of charcoal iron in 1874. South Carolina, with eight furnaces, and Minnesota, with one furnace, made no iron in that year.

The total imports of pig-iron into the United States in 1874 were 61,165 net tons, against 154,708 net tons in 1873, 295,967 net tons in 1872, and 245,535 net tons in 1871.

The total exports of pig-iron from the United States to all countries in 1874 were 16,039 net tons, against 10,103 net tons in 1873, and 1477 net tons in 1872.

The following table affords an oversight of the growth of the pig-iron branch of the iron trade of the United States, from 1854 to 1874, compiled from the association's statistics:

Years.	Anthracite.	Charcoal.	Bituminous Coal and Coke.	Total.
1854	339,435	342,298	54,485	736,218
1855	381,866	339,922	62,390	784,178
1856	443,113	370,470	69,554	883,137
1857	390,385	330,321	77,451	798,157
1858	361,430	285,313	58,351	705,094
1859	471,475	284,041	84,841	840,627
1860	519,211	278,331	122,228	919,770
1861	409,229	195,278	127,037	731,544
1862	470,315	186,660	130,687	787,662
1863	577,638	212,005	157,961	947,604
1864	684,018	241,853	210,125	1,135,996
1865	479,558	262,342	189,682	931,582
1866	749,367	332,580	268,396	1,350,343
1867	798,638	344,341	318,647	1,461,626
1868	893,000	370,000	340,000	1,603,000
1869	971,150	392,150	553,341	1,916,641
1870	930,000	365,000	570,000	1,865,000
1871	956,608	385,000	570,000	1,912,608
1872	1,369,812	500,587	984,159	2,854,558
1873	1,312,754	577,620	977,904	2,868,278
1874	1,202,144	576,557	910,712	2,689,413

The nearest approximation to an estimate of the possible production of pig-iron during the year 1875 may be made from the accompanying data recently published by the *American Manufacturer*, of Pittsburgh, Pennsylvania. The figures have been compiled from returns received from 95 per cent. of the whole number of furnaces, and show the number of stacks in and out of blast in nearly every section of the country on the 1st of September, 1875, compared with those which made similar reports to the same journal at the same period of 1874. The number of furnaces reporting is as follows: In 1874, 575 stacks; in 1875, 664 stacks. Of these there were in blast, in 1874, 348 stacks, with a weekly capacity of 51,439 tons; in 1875, 289 stacks, capacity 47,008 tons. Out of blast, 1874, 227 stacks, weekly capacity 39,089 tons; 1875, 375 stacks, capacity 53,803 tons. The whole number of finished stacks in the country at the time of this report is estimated at 700. The above figures indicate that the production of 1875 will be much below that of 1874. We may hazard the estimate that it will not exceed 2,000,000 tons.*

[* Since the preparation of the foregoing summary, Mr. Secretary Swank has published an *estimate* of the pig-iron industry for the entire year 1875, The following table shows the production in net tons of all forms of rolled iron produced in the United States in 1874, compiled from the association's statistics. This table, arranged to show the production by states, includes bar, band, hoop, plate, sheet, angle, girder, beam, boat, guide, rod, and bridge iron and rolled axles. All forged iron, such as anchors, anvils, hammered axles, cranks, ships' knees, etc., is carefully excluded, because of the impossibility of learning, even approximately, the amount of iron hammered or forged based upon partial returns made to the association's office. The more important figures of this estimate we add herewith to supplement our preceding statements, viz.:

States.	Bar, Angle, Bolt, Rod, and Hoop Iron.	Plate and Sheet Iron.	Cut Nails and Spikes.	Iron and Steel Rails of all Sizes.	Total Rolled Iron.
Maine...........	3,994	....	....	14,650	18,644
New Hampshire.	300	....	....	....	300
Vermont........	....	....	....	10,400	10,400
Massachusetts...	40,324	6,592	28,819	24,765	100,500
Rhode Island....	7,170	....	3,446	....	10,616
Connecticut.....	11,921	....	....	....	11,921
New York.......	76,590	4,000	5,949	46,979	133,518
New Jersey.....	24,645	2,256	27,643	3,537	58,081
Pennsylvania....	343,632	120,098	75,151	259,288	798,169
Delaware........	6,860	4,958	....	....	11,818
Maryland........	8,455	12,428	....	48,008	68,891
Virginia.........	11,086	....	5,602	....	16,688
Georgia.........	1,496	....	....	8,061	9,467
Alabama........	1,000	....	....	....	1,000
West Virginia...	1,609	....	54,201	522	56,332
Kentucky.......	18,239	5,120	5,121	6,068	34,548
Tennessee.......	1,573	....	660	13,693	15,926
Ohio............	105,413	5,143	27,253	82,561	220,370
Indiana.........	7,376	....	7,514	20,617	35,507
Illinois..........	2,500	2,240	4,250	125,103	134,093
Michigan.......	4,207	1,553	....	2,448	8,208
Wisconsin.......	275	....	....	29,680	29,955
Missouri........	1,500	10,870	....	24,017	36,387
California.......	9,205	....	....	7,016	16,221
Texas..........	....	....	....	2,000	2,000
Total.......	689,280	175,258	245,609	729,413	1,889,560

Total pig-iron production for 1875 (estimated)..	2,068,696	net tons.
Decreased production as compared with 1874...	620,717	"
Whole number of furnaces in 1875..............	713	"
Number in blast December 31, 1875............	345	"
" out of blast " "	368	"

—*Ed.*]

in the vast number of machine-shops, locomotive works, marine-engine works, and similar establishments throughout the country.

The total production of all rolled iron in 1874, Bessemer rails included, was 1,839,560 net tons, against 1,966,445 net tons in 1873, a decrease of only 126,885 net tons. This decrease was all in rails. In the following table is presented a summary of the production of all forms of rolled iron in the United States from 1864 to 1874 inclusive.

Years.	Rails.	Other Rolled Iron.	Total.
1864	335,369	536,958	872,327
1865	356,292	500,048	856,340
1866	430,778	595,311	1,026,089
1867	462,108	579,838	1,041,946
1868	506,714	598,286	1,105,000
1869	593,586	642,420	1,236,006
1870	620,000	705,000	1,325,000
1871	775,733	710,000	1,485,733
1872	1,000,000	941,992	1,941,992
1873	890,077	1,076,368	1,966,445
1874	729,413	1,110,147	1,839,560

The total production of rails of all kinds in the United States in 1874 was 729,413 net tons, against 890,077 tons in 1873, 1,000,000 in 1872, and 775,733 tons in 1871. About one half of the total rail product of 1874 was made up of old rails re-rolled. The total importation of new rails in 1874 was as follows: Of iron, 7796 net tons; of steel, 100,486 net tons: total, 108,282 tons. The probable consumption of rails during the year was therefore 837,695 net tons, against 1,148,850 tons in 1873, and 1,530,850 tons in 1872.

The eight completed Bessemer works in this country, although not fully occupied during the year 1874, turned out, according to the figures of the association, a greater product than that of 1873. The production of Bessemer steel rails in 1874 was 144,944 net tons, against 129,015 in 1873—a gain of 15,929 tons. The production of Bessemer steel rails in this country since 1867, when they were first made upon orders, has been as follows in net tons:

Year.	Tons.	Year.	Tons.
1867	2,550	1871	38,250
1868	7,225	1872	94,070
1869	9,650	1873	129,015
1870	34,000	1874	144,944

The total quantity of pig-iron, converted by the Bessemer or pneumatic process was 140,404 net tons in 1872, 183,534 tons in 1873, and 204,352 tons in 1874. The secretary estimates the probable production of Bessemer rails in the United States during the year 1875 at fully 250,000 net tons.

The following additions to the Bessemer works in the United States in 1875 are reported: The Edgar Thompson Steel Company, Limited, made its first blow on August 26th last; started its blooming-mill on Friday, August 27th; and rolled its first rail on Wednesday, September 1st. The works at once went into full operation. The Lackawanna Iron and Coal Company followed on the 23d of October. This company makes the tenth that is now engaged in making Bessemer steel rails in this country, and we learn that the foundations for the Bessemer plant of the Vulcan Iron Works at St. Louis have lately been laid.

The secretary of the association furnishes, furthermore, the following statement of the quantity of Bessemer ingots made in Great Britain in gross tons: In 1870, 215,000 tons; in 1871, 329,000 tons; in 1872, 410,000; in 1873, 496,000; and in 1874, 540,000; and draws attention to the fact that when the three new Bessemer establishments are all put in operation—making eleven in all—the capacity to produce Bessemer steel will be as great in this country as it now is in Great Britain.

The following table shows the production of steel, other than Bessemer, in this country during the past ten years in net tons:

Year.	Tons.	Year.	Tons.
1865	15,262	1870	35,000
1866	18,973	1871	37,000
1867	19,000	1872	38,000
1868	21,500	1873	50,000
1869	23,000	1874	47,481

The production of open-hearth, or Siemens-Martin steel, is steadily increasing in this country. In 1872 it amounted to 3000 net tons; in 1873 to 3500 tons; and in 1874 to 7000 tons.

We compile, finally, from the foregoing statistics of the production of pig-iron, rails, bar-iron, steel, etc., in the United States in 1872, 1873, and 1874, the following table of the aggregate production of iron and steel, embracing the different branches of the iron trade:

Products—Net Tons.	1872.	1873.	1874.
Pig-iron	2,854,558	2,868,278	2,689,413
All rolled iron, including rails	1,941,992	1,966,445	1,839,560
All rolled iron, including nails and excluding rails	941,992	1,076,368	1,110,174
Rails of all kinds	1,000,000	890,077	729,413
Bessemer steel rails	94,070	129,015	144,944
Iron and all other rails	905,930	761,062	584,469
Street rails	15,000	9,430	6,739
Kegs of cut nails and spikes	4,065,322	4,024,704	4,912,180
Merchantable Bessemer steel other than rails	16,430	27,985	31,635
Total Bessemer steel	110,500	157,000	176,579
Crucible cast steel	27,260	32,786	34,128
Open-hearth steel	3,000	3,500	7,000
All other steel	7,740	13,714	6,353
Blooms from ore and pig-iron	58,000	62,564	61,070

From the *Engineering and Mining Journal*, which claims to have devoted especial care to the collection of authentic statistics upon this subject, we give the following statement of the coal production of the United States for the year 1874. The totals are in net tons. During the year 1874 there was produced—

Anthracite	24,281,471
Bituminous	25,248,684
Lignite	1,217,020
Total	50,747,175

Or 45,209,980 gross tons.

The great strike in the anthracite region during the past year, and which was finally terminated by the complete submission of the miners to the operators' terms, was one of the most obstinately conducted and disastrous in its results that have ever taken place in the country.

At the time of writing we have no data at hand upon which to base an estimate of the total coal production of the past year. The same journal *estimates* the production of anthracite during 1875 to have been 21,441,000 gross tons. The technology of this subject will be found in its appropriate place.

The statement of the production of the precious metals in the United States shows that the gold yield is gradually declining, while that of silver increases. The twenty-six years from 1848 (the first year of a gold yield in California) to 1873 are embraced in the statement.

During this period the average annual gold yield was $50,800,000, while the average annual yield of silver was $13,300,000. The highest gold production was between the years 1851 and 1857, when it exceeded $55,000,000 a year. The highest annual silver production was in 1873, when it reached $37,750,000. With the exception of one or two years, the gold production has steadily decreased from 1857, while the silver production has steadily increased since 1859. About the year 1873 the proportion of the one about equaled that of the other. The annual statement of the production of the precious metals in the states and territories west of the Missouri River (including British Columbia) for the year 1874 shows an aggregate yield of $74,401,065, being an excess of $2,142,362 over that of 1873. The discovery of the great "bonanza," or ore-body, on the Comstock lode, during the past year, will doubtless swell the figures of silver production enormously. The Annual Report of the Director of the Mint to the Secretary of the Treasury enables us to bring forward the statistics of the domestic production of the precious metals to June 30, 1875. For the year ending with the date just given, the director gives the following values, viz.:

Arizona...........	$1,000,000	New Mexico......	$1,000,000
California.........	17,000,000	Utah..............	6,844,570
Colorado..........	5,472,000	Oregon............	1,665,000
Idaho..............	2,500,000	Wyoming Ter.......	250,000
Montana..........	4,119,852	Washington Ter....	300,000
Nevada...........	31,795,193	Total.........	$71,946,615

In view of its growing importance, it may not be amiss to notice in our statistical summary the condition of the American Silk Industry, as presented in the report of the Secretary of the Silk Association of America. This document embraces comprehensive facts and figures, bringing up the statistics of this growing industry to December 31, 1874. From these statistics we learn that thirteen states manufactured silk goods during 1874, distributed as follows in firms and corporations: New Jersey, 42; Connecticut, 21; New York, 70; Massachusetts, 11; Pennsylvania, 23; California, 3;

Ohio, 3; Illinois, 2; and New Hampshire, Vermont, Maryland, Missouri, and Kansas, each 1; total, 180. The total number of operatives employed was 14,479; of whom 4086 were males above the age of 16; 1048 were males under 16; 6858 were females over the age of 16; and 2478 females under the age of 16. The wages paid amounted to $4,497,319; the value of the capital invested and employed was $14,708,184; and the total value of the year's production amounted to $20,082,482.

We have at hand the detailed statement of the exports and imports of the United States for the fiscal year ending June 30, 1875, issued by the chief of the Bureau of Statistics; from which it appears that our total imports during that period were valued at $553,906,253, a decrease of $41,954,995 as compared with those of the previous year. Our exports during the same period were valued at $643,081,433, a decrease as compared with the previous year of $49,957,621.

Railroads.—For the year 1875 we may record, as far as ascertained, the construction of 1483 miles of new railroads in the United States. Some additions to these figures will possibly have to be made, but when returns are complete the total for the past year will hardly exceed 1500 miles; showing a decrease of about 25 per cent. as compared with the figures of 1874, of over 60 per cent. with those of 1873, and of over 80 per cent. as compared with the figures of 1872. Our estimated figures of new construction for 1874, published in last year's *Record*, require but a trifling correction, as will be apparent from the appended statement:

Mileage constructed in 1872 (ascertained)	7340
" " in 1873 (")	3833
" " in 1874 (")	2025
" " in 1875 (estimated)	1483

The most important lines completed this year are the New York and Canada, along the west shore of Lake Champlain, and an extension of the Southern Pacific in Southern California; neither of these is very long.

The leading event in railroad business during the past year was the long competitive contest begun by the Baltimore and Ohio and the Pennsylvania Railroad Companies in March, 1875, and continued between all the lines from the East to the Northwest until September. The establishment of the Southern Railway and Steamship Association in October last, for the purpose of regulating competitive business in the Southeast, may prove to have been the most important event of the year. During the year, likewise, the State of Missouri established a Railroad Commission, and enacted severe laws regulating rates. The State of Minnesota repealed its laws regulating and limiting rates minutely, and substituted a Commission with power only to investigate and recommend. The Erie Railway Company was added to the long list of American roads unable to pay interest on their funded debt. Of nearly $500,000,000 of railroad bonds which had ceased to pay interest before the close of 1874, payment was resumed only in one or two cases. Several railroads were sold under mortgage during the year; arrangements were completed to obviate a foreclosure in several cases, but a large number of companies have not yet completed any settlements with their creditors. Railroad traffic was generally lighter than in 1874, and rates lower; expenses were likewise somewhat lower.

In railroad improvements perhaps the most notable events were a more extended application of Hall's Electric Signal system, especially on Boston railroads; the introduction of the well-known Saxby & Farmer interlocking signal and switch system—much used in England—on the Pennsylvania Railroad; and a system intended to effect the same objects by the New York Central and Hudson River Railroad, the invention of two officers of that road, Messrs. Toucey and Buchanan. The Saxby & Farmer system has been in operation upon the principal railroads of England, with such eminent satisfaction that by Act of Parliament its use has been declared obligatory on all new lines in that country. The following brief comments, from one of our leading journals, will convey some idea of the merits of the system: "Unless an engine-driver deliberately shuts his eyes to prominent danger signals, and intentionally dashes his train to destruction, it would seem that with the Saxby & Farmer mechanism an accident is hardly possible. The switch-tender is utterly precluded from making a blunder, either in signals or in locking or setting his points. The very worst he can do is to neglect his duty altogether, and the only result arising therefrom would be a temporary stoppage of the trains. He can not shift points during the passage of a train and so send the rear cars off the track, nor can he easily signal a line clear until such is the case. The characteristic feature of the Saxby & Farmer system is its absolute positiveness." For the Toucey & Buchanan system merits no less positive are claimed.

The past year has witnessed, likewise, a considerable extension of the employment of continuous power-brakes. On both sides of the Atlantic an unusual degree of interest was manifested upon this point; in England, indeed, the government, with commendable appreciation, has referred the problem to a Royal Commission for exhaustive examination and report. The conclusions of this body have not yet transpired. In this connection we may note that the hydraulic system, as distinguished from the atmospheric, appears to be steadily gaining ground. With the several forms of atmospheric brakes in use, despite their great merits, the great complexity of the apparatus, and its liability to become deranged in consequence, are serious objections, which in the hydraulic system—certainly in the best representatives of this class—are largely obviated. It is of interest, therefore, to remark that the record made during the past year by the Henderson Hydraulic brake—the pioneer in this field, to which we made brief allusion in our last volume—was as satisfactory as the warmest advocates of the system could have desired. Assuming this particular brake to be the representative of its class, it may be safely affirmed that it has demonstrated the hydraulic system to be prompt in action, reliable, requiring little care and no skilled attention, advantages which can not fail ultimately to tell strongly in its favor.

Steel and steel-tired car-wheels found some favor during the past year as substitutes for the prevailing chilled cast-iron ones. There was evident some reaction against the use of steel for locomotive fire-boxes. The tendency to use heavier locomotives on railroads with heavy traffic has continued. The use of separate tracks for freight on the New York Central and Hudson River Railroad has made a material saving in the movement of freight, though the traffic has not been sufficient to crowd the old tracks. The New York railroads carried more than ever before of the grain between Lake Erie and tidewater, though canal rates were never before so low.

The fiftieth anniversary of the opening of the first public railroad worked by steam was celebrated at Darlington, England, on September 27, 1875. On the same day, by a curious coincidence, a rolling-mill (at Stockton) began rolling rails for the first Chinese railroad, a charter for which has been granted to a company of Englishmen and Americans.

German railroads, at the beginning of the year, were authorized to increase their tariffs on freight (with the exception of certain necessaries of life) to the extent of not more than twenty-five per cent., on account of great reductions in profits through the rise some years before in wages and materials.

There was much discussion in France on the providing of railroads of local interest, the problem being to prevent such roads from injuring the business of existing roads, which have a government guarantee of interest on a large part of their capital.

The Railway Commission established in Great Britain, in 1874, as a species of court having jurisdiction over certain cases of differences between railroads and the community, and of railroads with other railroads, has heard and decided many cases during the past year, and has proved itself to be a valuable tribunal. One of the members is an old railroad manager (and is required by law to be an expert in railroad business), another is a lawyer, and the third a nobleman.

There has been a general stagnation in the work of railroad construction during the past year in almost all countries, with the exception perhaps of Russia.

The railway statistics of the world have been collaborated with considerable accuracy up to the close of the year 1874; at which date we may estimate the length of all the railways of the world, from the best sources of information at our disposal, to have been 178,237 miles, with 56,700 locomotives (having in the aggregate 1,134,000 horse-power), 103,700 passenger, and 1,356,000 freight cars.

An outgrowth of the numerous transportation schemes advocated at the last session of Congress was a government survey for a railroad from the Tennessee River to the Atlantic Ocean. The line in question is proposed as a cheap freight route for the grain and other produce of the Mississippi Valley. The line surveyed begins at Guntersville, Ala., on the big bend of the Tennessee River, and runs in an almost direct line to its proposed terminus, the harbor of Brunswick, on the southeastern coast of Georgia. Its length is 412 miles.

The considerable progress made during the year toward the completion of the Underground Railway system in the city of New York, referred to in our last year's *Record*, is worthy of remark. The discussion of the rapid-transit problem, the necessity for some system of which has become imperative, culminated in the appointment by the Mayor of a commission empowered to select routes and decide upon plans. This commission, after an examination of numerous systems and designs, and full consideration of the subject in all its bearings, selected the following routes:

On the west side of the city, the present line of the Greenwich Street elevated railroad is to be continued up Ninth Avenue to the Harlem River. Another route is to be by Sixth Avenue to Fifty-ninth Street, and there to connect with the Greenwich Street road. On the east side, the road will pass up Third Avenue, or as an alternative up Second Avenue, to Harlem Bridge, and will have branches to the ferries and the Central Dépôt. The plan of road decided upon by the commission is an elevated structure. It is expected that these plans will be realized in practice before the end of the year 1876. During the past year, likewise, the councils of the city of Philadelphia granted the right to the Philadelphia Pneumatic Company, incorporated by act of Legislature, to construct, operate, and maintain a railroad with one or more tracks, to be located beneath the surface of Broad Street, and to extend therefrom to a number of the railroad dépôts. The purpose of the company, as expressed in the ordinance, is to improve and increase the facility, rapidity, and convenience of transit between the business portion of the city and the various railroad dépôts. Thus far, however, no steps have been openly taken to carry this project into effect.

We append, finally, to conclude our record of railroad events, a tabulated statement of accidents to railroad trains in the United States for one year ending with last December. For these statistics (as likewise for those of mileage) we are indebted to our admirable contemporary, the *Railroad Gazette*.* This accident table is the only one of the kind, published at home, for the whole country, and contains, probably, most of the accidents resulting in personal injury. For the year ending with December, the record is as follows:

		No. of Accidents.	Killed.	Injured.
January,	1875	131	10	96
February,	"	211	11	186
March,	"	122	17	73
April,	"	60	9	67
May,	"	54	6	43
June,	"	61	23	67
July,	"	73	33	50
August,	"	114	27	110
September,	"	116	50	182
October,	"	88	12	74
November,	"	87	24	97
December,	"	84	12	62
Totals		1201	234	1107

Engineering.—The most important item in the province of *Engineering* is the inauguration of the difficult work of improving the channel of the Mississippi River at its mouth, so as to render the same a permanent thoroughfare to the Gulf of Mexico, by which the river ports will be opened to direct ocean traffic for vessels of the deepest draft. After much discussion of the rival merits of plans involving the building of canals (see last year's *Annual Record*), the subject was finally settled by an appropriation, at the last session of Congress, for the construction of a system of jetties and auxiliary works at the South Pass of the river. The plans adopted are those of Captain J. B. Eads, the constructer of the great steel bridge at St. Louis, under whose superintendence the work has been commenced, and considerable progress already made. By the nature of the contract, the work has been undertaken at the sole risk of Captain Eads and his associates, inasmuch as no payments are to be made by the government until certain stipulated depths of water have been secured and maintained. The act of Congress provides that when a depth of twenty feet shall have been secured a certain payment shall be made, and so on up to thirty feet; that twelve months after each of the prescribed depths has been secured a further payment shall be made, provided the same has been maintained during that time; and that $100,000 shall be paid annually during twenty years, for maintaining the works after construction, and for extending them if necessary, so as to keep the channel at the required depth. The plan of the work is remarkably simple. It contemplates the removal of the point where the sediment of the river is at present deposited, namely, in the shallow water at the entrance of the pass, farther out into the deep water of the Gulf, where filling up again by natural causes will be an indefinitely remote possibility. To accomplish this object, the banks of the pass will be extended, so as to carry the stream far enough out, by the creation of artificial walls within which the waters of the mouth will be confined, said walls being so proportioned in width to the quantity of water escaping as to produce an increased velocity of current, and thus force the stream to scour out for itself a channel of required depth. Extensive lines of jetties will therefore be constructed along the course of the moving waters, the jetties being simply dikes or levees under water which are intended to act as banks to the river, to prevent it from expanding and diffusing itself as it enters the sea. The greatest difficulties to be overcome were to devise means of creating these artificial walls, and making them secure and permanent upon the exceedingly unstable foundation of soft sediment, into which any works of stone would speedily sink and disappear. Piles alone, or crib-work, however firmly placed, would soon be undermined and swept away by the scour of the current. To meet these difficulties, Captain Eads builds the artificial walls of the river with broad, flat mattresses of willow-brush, securely lashed together and anchored to an interior row of piles. The preliminary work is the driving of piles along and inside of the line for the proposed structure. Meantime great mattresses of willow-brush are constructed, firmly locked together with cross-ties and pins. These mattresses are towed into position adjoining the piles, and fastened to them. If placed at night, by morning the deposit of sediment from the current has so filled the interstices as to sink them so that they rest upon the bottom. Each mattress is not only fastened to others adjacent and to the piles, but it is anchored in its place by a layer of stone, and the sediment continues to gather in upon them until they become more solid and enduring than any part of the natural bank. When completed, the wall of mattresses will perfectly protect the row of piles from the current, while the piles in turn serve to hold the mattresses in position; and the whole will be finally covered with a firm stone paving. The outer ends of the walls, where they are exposed to the sea, will be constructed of broader and stronger mattresses, supporting solid and durable works. It will be the work of years to complete the whole structure; but its benefits will begin to be manifest directly, for the channel will rapidly deepen as fast as it is confined within the walls. It is calculated that these will have been so far completed at the close of 1875 that the largest ships ever seen in New York harbor can enter the South Pass at any time and proceed without delay to New Orleans. A board of eminent engineers, invited by Captain Eads, with the approval of the President, to examine and pass judgment upon his plans, has, after careful consideration of the subject in all its details, emphatically indorsed the feasibility of the undertaking.

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* For much of what is of value in the foregoing summary of railroad news we are under obligations to the courtesy of Mr. S. Wright Dunning, editor of the *Railroad Gazette*.—*Ed.*

The government operations at Hallett's Point for the removal of the obstruction to entering the East River by way of Long Island Sound are fast approaching completion. The work, which is under the superintendence of Captain W. H. Heuer, United States Engineer, was begun in 1869, and has cost up to the present time about $750,000. After a tedious labor of nearly six years, the task of excavation was completed about last July, and the secondary work of preparing for the grand blast is now going on. The excavation extends under two and a half acres of gneiss rock vertically stratified. Starting from a main shaft thirty-four feet below mean low water, ten main headings, sloping down to fifty-two feet below mean low water, have been extended out to an average length of 250 feet each. The height of these main headings varies from eight to twenty-two feet, with an average width of fourteen feet. From the main headings intermediate headings have been cut, and at uniform distances circular galleries have also been cut across the headings, forming a series of columns or piers at the points of intersection, by which the roof is supported. The work of demolishing the reef will consist in breaking up these piers and shattering the rocky roof. The boring of holes in the roof and the columns has been progressing for some months, a number of Burleigh rock-drills being employed for that purpose. Captain Heuer expects to complete the drilling about the last of January. The work of charging will then be commenced, and will probably occupy two months longer. The nitro-glycerine, which will be used for the explosion, will be placed in iron tubes, each of which will have a direct battery-connection, besides being connected with adjacent holes by means of a series of smaller tubes filled with the same explosive. When all is ready the water will be let into the excavation, and the whole series of charges exploded simultaneously by electricity. It is proposed to fire the mine on the Fourth of July, 1876.

At Flood Rock, likewise, the work of excavation was commenced last June. The same system will be pursued as at Hallett's Point, but the excavations will be much greater in extent, as the rock stretches out about 400 feet in two directions from the shaft. At the time we write, a shaft ten by forty feet in plan, and sixty feet deep, has been sunk, from the bottom of which tunnels will radiate until the whole reef shall have been undermined. Thus far but two tunnels have been started, which are in about twenty feet and thirty feet respectively. Only a commencement has been made, the survey being as yet incomplete. The reef embraces over six acres of area, and the time necessary to complete the work will depend entirely upon the action of Congress in making appropriations. The removal of the reef at Hallett's Point will materially lessen the dangers of the Hell Gate passage, and be a permanent advantage to commerce even before the second and more difficult enterprise is brought to a sucessful conclusion.

The government works at League Island Naval Station are being rapidly advanced. The buildings already erected, but not yet finished, are the Iron-plating shop, 270 by 85 feet, and which will be connected with the Naval Constructer's Department, and the Yards and Docks Building.

The latter is 230 by 65 feet, and is nearly finished. Opposite this will be the storehouse for steam-engineering, to be 400 by 500 feet, now being erected. In the rear of this is the engine-house, containing an engine of sufficient power to supply the entire power for the station; and near by the Fire Department house, with two steamers and a supply of hose ready for use. It is proposed to divide the entire island into squares of 400 by 200 feet, of which there will be sixty, used by the various departments for an infinite variety of uses. The floating-dock basin projected will be thirty-one acres in extent; a repairing basin will be thirty acres; a storage dock basin, seven acres; and a fitting-out basin, forty acres. The floating-dock basin will be on the Delaware side, and connected by numerous railroad tracks with various departments. The quay wall on the river front will have a water-depth of twenty-eight feet, while the river here is 2800 feet wide. The main avenue will be 125 feet wide; an avenue parallel with the river, eighty feet; and all other streets and thoroughfares, seventy-five feet. The plan comprises a system of floating-docks, combined with shallow basins and railroad tracks, for raising ships and taking them on shore, and by this means a large number of ships can be provided for at once. When all the dredging and digging is completed, there will be an aggregate of 155 acres of deep water. The area will be divided as follows: The Bureau of Steam Engineering will have nineteen acres' space; Coal Bureau, thirty-six acres; Bureau of Ordnance, twenty-four acres; Bureau of Provisions, eight acres; Bureau of Yards and Docks, seventeen acres; and the Marine Corps, twenty-one acres. When completed, the League Island Naval Station will be a yard as finely arranged and as convenient for the purpose as can be found in the world.

A commission of government engineers has lately made an investigation and report upon a permanent plan of reclaiming the alluvial lands of the Mississippi now subject to inundation. The total area of the bottom-lands is approximately 32,000 square miles, of which but a narrow strip along the main stream and its tributaries is open for cultivation; while it is affirmed that with proper protection against inundation from the river, and efficient drainage, no less than ten million acres of land of extraordinary fertility would be reclaimed for cultivation. The Commission, in its report upon this subject, recommends the perfecting of the levee system. The diversion of tributaries, artificial reservoirs, cut-offs, and artificial outlets are declared to be impracticable. The report recommends that the Atchafalaya and the La Fourche be kept open, that the Plaquemine be reopened, if borings shall show it to be practicable, and that a general levee system be established which shall extend from the head of the alluvial basin to the Gulf, and shall include the valleys of the tributaries. The proposed levees will be of sufficient height and strength to resist the action of the water and to restrain the floods. The cost of the proposed improvement is roughly estimated at $46,000,000.

The degree of success that has attended the introduction of steam-power on the canals of the State of New York will be best appreciated by the perusal of the following extracts from a lengthy report of the State Engineer and Surveyor in response to a resolution of the Assembly, passed February 5, 1875, asking for information on the subject. At the close of an historical sketch of some length, the report has the following statements: "I am of the opinion that the question of economy and adaptability of steam as a motive-power on the canals of this state is removed beyond the sphere of experiment, and that ultimate and complete success now depends upon capital alone. When adverse interests shall be reconciled, when the continued success of the present steamers shall have convinced the timid and doubting capitalist, and when the facts already developed shall be more widely disseminated, and shall receive the credit to which they are clearly entitled, I feel sure that the general introduction of steam will proceed rapidly to a complete and successful accomplishment. The simple fact that under no circumstances likely to occur can steamboats be introduced more rapidly than the present horse-boats will disappear, should satisfy those who are interested in the latter, and who fear embarrassment from the change, that the transition may be effected without serious loss or inconvenience to them."

The subject of interoceanic communication across the American isthmus has received several important contributions. During the past year two government expeditions were at work upon preliminary surveys for a ship-canal—one upon the route generally known as the Atrato and Napipi; the other upon the Chepo route, and upon a line nearly coinciding with that of the present Panama Railroad. The first expedition, under the command of Lieutenant Frederick Collins, U. S. N., formerly on Commander T. O. Selfridge's staff on the Atrato, re-examined and completed the survey of the route recommended by Commander Selfridge in 1871 and 1873. The party under Lieutenant Collins ran a new line of survey from the Atrato to the Pacific, following the Napipi Valley to its junction with the Doguado River, thence to its head-waters, and thence, crossing the divide at an elevation of 778 feet, to Chiri-Chiri Bay.

The direct distance is but 28 miles; the necessary curves increase this to 30.2 miles. Plans for a canal by this route will show a summit level of 143 feet above mean tide, a tunnel of 3.5 miles, and the use of 22 locks. Estimated cost, including twenty-five per cent. for contingencies, $100,000,000.

Lieutenant Collins reports, as a digest of the advantages and disadvantages of this route, in substance as follows: The character of much of the soil to be excavated is favorable for stable embankments and defense against loss by leakage or infiltrations; other advantages are the shortness of the artificial channel, excellence of harbors on each side, freedom of the location from terrestrial convulsion, abundance of material for construction, comparative facility for obtaining labor, and friendly disposition of the government and of the natives. The heaviest work would be on the Pacific side, which is more healthy and offers facilities for transportation.

The disadvantages lie chiefly in the necessity of a tunnel (its expense of construction and want of adaptability for commerce), the steep descent toward the Pacific requiring (like the almost unused Caledonia Canal) the grouping of a number of locks, limited water-supply during the dry season, dangers to constructions during the floods, shortness of season available for work, and undeveloped state of the country.

The expedition under Commander E. P. Lull, United States Navy, had for its objects the exploration of a route across the Isthmus of Panama, and to make likewise such examination of what has been known as the Chepo or Bayanos route as would test the practicability of a ship-canal line from the mouth of that river to the capacious harbor of San Blas on the Pacific. This last was proved to be "hopelessly impracticable."

Across the Isthmus of Panama a feasible line was located. Total length, 41.7 miles; summit level, 129 feet; locks required, 12 on each side, and a tide lock at Panama; supply of water ample, to be obtained by a feeder from the River Chagres; estimated cost, $80,000,000. In connection, however, with any estimate for a line across this part of the isthmus, it must be remembered that it will be located within the section to which, under the renewed contract with the government of New Granada, the Panama Railroad Company has an exclusive right for canal or railroad.

All the explorations and surveys made on the American isthmus by our government during the last five years, viz., by Commodore Shufeldt across Tehuantepec; by Commander Lull across Nicaragua, Panama, and in Darien; and by Commander Selfridge and Lieutenant Collins on the Atrato route, have been referred by the President to a commission of engineers for examination and report upon their respective merits. This commission, composed of Major-General A. A. Humphreys, chief of Engineers; Commodore Daniel Ammen, chief of the Bureau of Navigation; and Captain C. P. Patterson, superintendent of the Coast Survey, will probably report on the whole subject at the coming session of Congress.* Mr. A. G. Menocal, C. E., who was Commander Lull's engineer on both of his expeditions, is now prosecuting inquiries at Greytown for the Nicaraguan government in reference to the work.† It is of interest, in connection with this subject, to notice that, after so many expeditions up and down the isthmus, the route now most favorably regarded should be between the two points of the isthmian region with which engineers have been quite familiar for the past twenty-five years. The interest of the local governments in the successful issue of the ship-canal project is manifested in the sending by the Nicaraguan authorities of an official letter on the subject of interoceanic communication to M. de Lesseps, of Suez fame; who, in reply, favors the Nicaragua route as the best, provided it should be found impracticable to build a canal across the Darien isthmus, and proffers his co-operation in the event of the practical undertaking of the work. Finally, perhaps the most inspiring incentive to our government for the accomplishment of some one of the numerous canals projected across the American isthmus will be found in an examination of the last published report of the Suez Canal Company, which brings forward the statistics of this enterprise to the beginning of April of the year just closed. We append a summary of the more important items of this report:

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* This commission has, since the above was written, reported in favor of the Nicaragua route.—*Ed.*

† For valuable information on this subject we are indebted to Professor J. E. Nourse, of the United States Naval Observatory, Washington, D. C., than whom the interoceanic canal enterprise has no abler advocate.—*Ed.*

The Suez Canal was opened to international commerce in the month of December, 1869, since which time, up to April 1, 1875, 5236 vessels made the transit, 2863 passing through from the Mediterranean, and 2373 from the Red Sea. Of the grand total, 238 were sailing craft and the remainder steam-vessels. The following figures, by years, will best illustrate the progressive increase in traffic:

Year.	Vessels.
1870	498
1871	763
1872	1082
1873	1173
1874	1264
First quarter of 1875	455
Estimated traffic for the past year	1820

The canal has become one of the main arteries through which the world's, and especially Great Britain's, traffic moves. The trade of Europe with the East has been virtually revolutionized within five years, inasmuch as the overland carrying trade has almost ceased to exist; the general trade of the East being to a great extent carried by the canal. The gist of the report, however, may be condensed in the statement that the great undertaking has commenced to "pay." In 1870, the net tonnage amounted to 436,609, yielding to the company 5,048,944 francs; in 1874 it had reached 1,631,640, yielding 24,748,900 francs. The company's annual expenses amount to less than 5,000,000 francs, from which it may be reasonably inferred that, at the rate of increase which has hitherto taken place, the Suez Canal will in a few years more have achieved, from a commercial point of view, a most brilliant success.

At the last session of Congress an appropriation of $300,000 was made for the improvement of the Great Kanawha River from the Great Falls to its mouth, a work which, when realized, will complete a very important link of what is known as the "Central Water-line," connecting the James River at Richmond with the Ohio River at the mouth of the Kanawha. The distance from the Great Falls of the Kanawha to its mouth is 94½ miles, and the cost of improvement has been estimated at $3,000,000, which Congress will doubtless be called upon to appropriate in annual installments. In order that the money already appropriated should be used to the best advantage, the Secretary of War appointed a Board of Engineers with instructions to give the matter careful examination. This body, after a thorough investigation on the ground, decided to recommend the construction of stone locks, and to expend the $300,000 in building the first on the flats below Charlestown, Western Virginia. This lock is to be 300 feet long and 50 feet wide.

From abroad we may record that the Italian government has been engaged in the consideration of plans for the improvement of the Roman Campagna, a work which is warmly championed by General Garibaldi. A number of plans to effect the drainage of the numerous marshes, and the prevention of the frequent inundations of the Tiber, have been proposed, but thus far no definite plan of operation has been adopted. The experiment of introducing the malaria tree (*Eucalyptus globulus*) on a large scale is likewise said to be seriously contemplated, although the experiments already made in Italy have not proved satisfactory. The plan advocated by Garibaldi contemplated among other objects the construction of a canal from Rome to Ostia. This canal is to be available for navigation and irrigation purposes. The cost of construction is estimated at $6,000,000.

The problem of opening the interior of Africa to commerce has been earnestly advocated in certain quarters during the past year. Our last year's *Record* contained a brief allusion to a proposition of this nature which was receiving some attention at the hands of the French engineers in Algeria. A plan, in its general features analogous to this last, was lately brought out and urged by Mr. Donald Mackenzie. The following is a brief synopsis of the arguments urged in its behalf: The Sahara is one of the greatest barriers to intercourse with the interior of the African continent; but, it is urged, a greater portion of this vast area, which was until a comparatively recent period the bed of an inland sea, may without very great difficulty be again restored to that condition, and be the means of distributing over the little known and to some extent wholly unexplored interior the produce and civilization of Europe and America. In the interest of this project several meetings have lately been held in London, at which Mr. Mackenzie presented his plans. "Although Africa," he said, "has an area of nearly a quarter of the entire land of the globe, it presents greater obstacles to human enterprise than any other part of the earth's surface, and thus, with immense natural wealth above ground and below, it is a lost continent, banished, as it were, from intercourse with the civilized parts of the world." His plan is to open a direct commercial highway from a point opposite the Canary Islands to the northern bend of the Niger at Timbuctoo, a distance of 800 miles, by removing a belt of sand and admitting the waters of the Atlantic Ocean to a vast depression in the Great Desert, having an area of 126,000 square miles. Timbuctoo would thus become a seaport about 2000 miles from England, and North Central Africa would be brought within reach of the harbors of Europe. However extravagant the foregoing proposition may appear, the alternative proposal to make a road, perhaps ultimately a railroad, along the depression of that ancient sea-bottom which extends from Cape Juby to the negro metropolis, seems to be a feasible and useful project. The promontory named faces the Canaries, and is consequently close to the southern provinces of Barbary. A diagonal line drawn thence to Timbuctoo, 900 miles distant, crosses the western portion of the Sahara, but the route leads through a comparatively low country, with convenient resting-stations and watering-places. From Timbuctoo the Niger is navigable for over a thousand miles. At present there is a caravan trade between Timbuctoo and Morocco and the other Barbary States of not less than $15,000,000 annually, by a route much longer, the dangers and difficulties of which greatly increase the cost of goods at Timbuctoo. It seems reasonable, therefore, as the advocates of this project claim, that, were trade directed into the safer, easier, and shorter channel proposed, the existing one would be necessarily closed, while the station at Cape Juby, being in direct communication by sea with Northern Europe, would soon engross the commerce of South Barbary, which is said to be one of the richest, healthiest, and most fertile countries in the world, possessing a population of over three millions, whose only present means of intercourse with Europeans is by a most difficult road across the ranges of the Atlas, the cost of transportation across which often exceeds seven times the value of the merchandise. If any of the speculative projects for opening Central Africa to European commerce are ever to be carried into effect, the undertaking will probably be initiated by first putting some such proposal as that last described into operation, which can be done at comparatively little cost.

Upon the East River Bridge work has been slowly progressing during the past year. The latest accounts report that the Brooklyn anchorage is completed, and waiting for the cables and for the completion of the New York tower. Another East River bridge project has been authorized by the Legislature of New York, and certain steps preparatory to its erection have already been taken. The new company proposes to bridge the East River from New York to the Long Island shore at the lower end of Blackwell's Island. At this point the river is comparatively narrow, and a pier can be placed on the island. The surveys and soundings for its location have lately been completed by Mr. G. E. Harding. The total length of the proposed structure will be, including approaches, about two miles. It is proposed by the company to erect the long span trusses upon the cantilever principle. It is furthermore proposed to lay railroad tracks across it, and to make connection with the New York Central and Hudson River tracks through a tunnel under Seventy-seventh Street, on one side, and with the Long Island, the Southern, and the Flushing and North Shore Roads, at its termination at Graham Avenue and Lockwood Street, on the other side. A new iron bridge over the Genesee Falls was completed last year for the Erie Railroad, and opened for traffic. A new suspension bridge over the Monongahela River, at Pittsburgh, was likewise contracted for. It is proposed to employ in its construction immense iron chains instead of the usual wire cables. An iron bridge across the Missouri River, at Atchison, Kansas, was completed on the 4th of August, and opened for traffic during the same month.

Work upon the new Bergen Tunnel of the Delaware, Lackawanna, and Western Railroad is progressing rapidly. Excavation was originally carried on from six shafts, which, together with the two outside ends, gave fourteen faces to work upon. The excavation is now about completed on four of the sections, so that there are but six faces at which work is being carried forward. Between shafts 3 and 4 there remains, at the time we write, 305 feet of heading to be done; between 4 and 5, 228 feet; and between 5 and 6, 109 feet; and in all about 1450 feet of bottom or bench work still to be removed. The total length of the tunnel, from face to face of the portals, will be 4270 feet. About 600 men are kept at work on the tunnel, the estimated cost of which will be $800,000. The work was begun in September, 1873, and, it is thought, will be completed by July, 1876.

A railroad tunnel under Newark Bay was likewise proposed during the past year. The approach to Jersey City from Newark across the marshes and the waters of Newark Bay (*via* the New Jersey Central Railroad) is effected by an elevated railway carried upon wooden piles. The unsafe condition of this structure during the winter and spring, and the yearly expense involved in keeping it in repairs—which has practically amounted to its rebuilding three times since its first completion—has led the company to seriously consider the practicability of building a tunnel under the waters of the bay from Elizabethport to Bergen Point. Prominent engineers consider the scheme a feasible one. A rough estimate places the cost of a tunnel for double tracks, extending a distance of 2½ miles, at $6,000,000, and which, if built, would last for a century.

The Channel Tunnel project, which contemplates the union of England and France by a submarine railway tunnel under the waters of the English Channel, has by no means been abandoned, as the following synopsis of the events of the past year in relation thereto will indicate. In April last the appointment of a joint commission by the English and French governments was announced. The duties of this body, which comprises eminent engineers of both countries, are to examine and report on the scheme of construction, so far as the same may affect the interests of either government. It is understood, furthermore, that the legislative concessions required for its construction have been granted by the two governments.

Latest reports state that soundings in the Channel are actively going on, and that the engineers in charge of the work are well satisfied with the results obtained. From Paris it is reported that preliminary operations prior to the commencement of the great undertaking have been begun. The members of the French Commission declare that an underground communication between France and England is only a question of expense; and the report they have drawn up and submitted to the French government, with the result of the soundings and of the study of the geological questions involved, is said to favor the belief that the project can be carried out with less expense than was at first imagined; and, finally, that the danger from leakage and infiltration will not be so great as was originally supposed. A shaft will shortly be sunk on the French side of the Channel, near Calais, to the depth of 350 feet, similar to that sunk some time ago on the English side, for the purpose of positively establishing the nature of the rock formation.

The details of the present situation of the project may be summarized as follows: In 1872 the Tunnel Company was organized, and Sir John Hawkshaw, Mr. James Brunlees, and M. Thomé de Gamond were appointed the engineers of the undertaking. On the English coast, St. Margaret's Bay, a depression in the chalk cliffs about four miles east from Dover, has been selected as the point of departure; and on the French side a spot about midway between Calais and the village of Sangatte has been fixed upon. By adopting this line, it is claimed from the observations of Sir John Hawkshaw, the tunnel can be almost wholly excavated in the lower bed of homogeneous chalk, this stratum being 500 feet deep on each shore from high-water mark. In establishing the basis for this opinion, an examination was made across the Channel by dropping, from a steamer, a weighted instrument in 500 places, the apparatus running with great velocity to the bottom, and bringing up chalk where it was expected. The current is so strong along the proposed line that the bottom is washed quite clean, as the experiments conducted showed the absence of any deposit. From the examinations made there is every reason to believe that the chalk is continuous, and that it stretches beneath the sea uninterruptedly across the Channel. The maximum depth of water on the line of the proposed tunnel nowhere exceeds 180 feet below high-water mark, being deepest in the centre, and gradually diminishing in depth toward the sides. The tunnel itself would be placed by the engineers at such a depth that the thickness of the rock-bed over it would be nowhere less than 200 feet; and this depth, which is ample for security, would permit the railway approaches to be formed with tolerably easy gradients. The danger to be apprehended from the possible existence of fissures in the chalk, and consequent infiltration, is answered by referring to the experience had during the construction of the Brighton Tunnel, through the comparatively incompact upper chalk, for a distance of five and a quarter miles along the sea-shore, and from twelve to twenty feet below high-water mark, in close proximity to the margin of the sea. In this instance, although considerable water, mainly fresh, was met with, the work of construction was not notably obstructed in consequence. The engineers, finally, are unanimously of the opinion that the problem of ventilating the tunnel is easy of solution.

The future disposition of this magnificent scheme will probably be that the preliminary work (involving perhaps the cutting of galleries from both sides some distance under the sea) will be continued by private enterprise, until the feasibility of the undertaking is either disproved or established beyond cavil. Should this last prove to be the case, as seems quite probable, the two governments interested will doubtless be asked to come to the aid of the enterprise by the grant of a liberal subsidy.

The work upon the Severn Tunnel, to which we referred in our last year's *Record*, has been fully undertaken by the Great Western Railroad Company. The tunnel will be about four and a half miles in length, one half of which will be under the River Severn. When completed it will connect, in the most direct manner, the mineral and populous districts of South Wales with Bristol and the South of England, and will doubtless form the express route from London to South Wales. The work of excavation was started in December, 1874, and at last accounts was progressing at the rate of fourteen to eighteen yards per week. During the past year, likewise, several schemes for tunneling the Mersey between Liverpool and Seacombe were proposed.

Upon the St. Gothard Tunnel considerable progress has been made during the interval between our last annual report and the time of this writing. The following is the official report of the condition of the works on the 24th of September, 1875. The tunnel has been bored on the side of Switzerland 2500 meters, and on the side of Italy 2000 meters. As the work, when completed, will be about 15,000 meters, or, more accurately, 14,920 meters, in length, there remains about 10,500 meters yet to be bored. The altitude of the northern entrance at Goeschenen will be 3608 feet above sea-level, and that of the southern entrance at Airolo 3756 feet. The highest point in the interior of the tunnel will be 3780 feet above the sea, and will be reached from the Goeschenen end by a rising gradient of seven to 1000; from the summit there will be a falling gradient of one to 1000 to Airolo. The approaches of the tunnel have not yet been begun. The tunneling is performed by compressed air-machines actuated by water-power, and the explosive employed is dynamite. The daily rate of progress, according to latest advices, averages a trifle over seven meters. It is anticipated that the year 1880 will witness the completion of the tunnel.

We may record likewise the formation of an international company to effect the tunneling of the Simplon Pass; also of a company under the title of the "Intercontinental Railway Company," the main object of which is said to be to effect the union of Europe and Africa by a tunnel under the Strait of Gibraltar. As projected, it will extend in a right line between Tarifa and Algesiras on the Spanish coast to Ceuta and Tangier on the Morocco shore. The submarine portion will be 44,160 feet, or nearly nine miles. This enterprise, thus far a mere proposition, will present far greater difficulties to its completion than the similar project for tunneling the English Channel, although the latter, as projected, will have more than twice the length of the former, inasmuch as the maximum depth of the Channel at the point to be traversed does not exceed 180 feet, while that of the Strait is 2621 feet. A tunnel beneath the Strait would therefore require to be bored at a much greater depth beneath the bed-rock—say about 1000 feet—which in turn would demand entry and exit galleries each about three miles in length.

The following miscellaneous items have a general interest in this department: The construction of a canal from Lake Michigan to the Mississippi River has of late been strongly advocated, as a means of lessening the cost of conveying the produce of the Upper Mississippi Valley to the sea-boards.—The sum of 8000 florins has been voted by the States-General of Holland for re-examining the project of draining the Zuyder-Zee, and for soundings to determine the quality of the soil at its bottom.—A subterranean pneumatic postal service is proposed between Paris and Versailles, in order to facilitate communication between the seat of the government at the latter, and the general service of the various departments at the former place. The line proposed is a double one, permitting the carriage of twenty kilos of dispatches an hour in both directions.—The Mexican Congress has lately granted an important concession, providing for the construction of a railroad of the standard gauge (four feet eight and a half inches) from the city of Leon, in the state of Jalisco, to the Rio Bravo del Norte, there to connect with the International Railway of Texas.—The opening of the Constantinople Underground Railway from Galata to Pera is worthy of mention. This unique work, which was thrown open for traffic in January last, is 672 yards long, and conveys passengers from the level of the Bosporus to the extreme height of Pera, an elevation of 200 feet, with an average gradient of one in ten. Its greatest depth below the surface is eighty feet, and the motive-power is a stationary engine working a drum with endless bands. Trains are carried up and down simultaneously every five minutes, and their carrying capacity is placed at 30,000 passengers per day.—After many delays, the cable of the United States Direct Submarine Telegraph Company was completed during the past year, and is now in practical operation. The line, it may be remarked, is laid between Ireland and Nova Scotia, and another submarine section from Nova Scotia to Rye Beach, New Hampshire. This is the fifth cable now in use in the Atlantic service.—The subject of the adoption of the underground telegraph system within the limits of cities gave rise to considerable discussion.—A recent diplomatic conference on the metrical system arranged for the organization of an International Bureau of Weights and Measures at Paris.—During the past year the metrical system has been introduced into Egypt.

The preparations for the great International Exhibition at Philadelphia are, at the time we write, in a very forward state. The rapidity with which the erection of the Exhibition buildings has progressed during the past year, and up to the time of our writing, has been most satisfactory; and it may be regarded as settled that they will all be completed and ready for their appointed uses before the time announced by the Centennial Commission for the reception of goods. When this condition of forwardness is contrasted with the confusion which ruled at the opening of the late Exposition at Vienna, on account of the backward state of the work of preparation—and which was the cause of much complaint and unfavorable comment at the time—the energy with which the work at Philadelphia has been prosecuted is a cause for sincere congratulation. The intense earnestness with which the Commissioners entered upon their labors, and the quiet but thorough manner in which they have effected the work of organization, finance, and construction have completely disarmed the hostile criticism of some, and aroused from their apathy and indifference toward the enterprise another large body of our citizens residing without the limits of Pennsylvania; so that now, as the time draws near for the opening, a very general interest in the success of the Exhibition is manifested throughout the country.

The number of applications for space by intending American exhibitors is very large, and the indications concerning the active participation of foreign nations are such as to warrant the belief that the success of the Exhibition is assured beyond peradventure. No fears are entertained that the entire amount of space available for various exhibits, enormous as it is, will not be fully occupied. The preparations being made by the various railroad companies centring in Philadelphia for the transportation of goods and passengers are of a very complete character, involving the erection upon the grounds of several commodious dépôts. The passenger dépôt of the Pennsylvania Railroad Company will be 650 by 100 feet, opposite to which will be a large hotel. The tracks will be in a new yard adjoining the Exhibition grounds, and will be laid in a circle 1000 feet in diameter, flattened on one side. Trains will discharge and proceed around the circle to the rear of the dépôt, where some fourteen large sidings will be arranged. There will be over seven miles of tracks in this yard, which will connect with the freight tracks through the Centennial Buildings; and the facilities for the transportation of passengers are very complete. A large dépôt for the Reading Company is likewise in course of erection near the Memorial Hall, while a number of other companies have effected, or design to effect, arrangements for the same purpose. On the score of steam railway facilities to and from the grounds, there will be little room for complaint; while the large number of city passenger railways, for which Philadelphia has been noted, have made or are making extensive arrangements for the accommodation of the enormous local traffic that will be thrown upon them.

In addition to the five Exhibition buildings proper, viz.:

Main building.........................	covering	21.47	acres
Art Gallery (Memorial Hall)...........	"	1.5	"
Machinery Hall........................	"	14.	"
Horticultural Hall....................	"	1.5	"
Agricultural Hall.....................	"	10.15	"

there will be a government building devoted to an exhibit of the operation of the several national Executive Departments, and of the Smithsonian Institution; a Women's Pavilion, for the exclusive exhibition of articles of women's handiwork, and a number of smaller structures for the administration of the Exhibition; in addition to which numerous applications have been made by manufacturers and by the Commissioners of foreign governments for permission to erect pavilions and numerous ornamental and useful structures within the Exhibition grounds, which applications in many cases have been granted.

The general reception of articles at the Exhibition buildings commenced January 5th, 1876, and will close on the 19th of April following; and every available means for the diffusion of information to intending exhibitors concerning the shipment of goods have been employed by the Bureau having this work in charge.

The Exhibition will be opened on the 10th of May, 1876, and closed on the 10th of November following. The removal of goods will not be permitted until the close of the Exhibition.

For detailed information concerning the Exhibition, we refer our readers to the official documents issued by the United States Centennial Commission in Philadelphia.

In close connection with the foregoing subject, we may mention that a plan has been organized for the establishment of an Industrial Museum—on the plan of the South Kensington Museum in London—to occupy Memorial Hall after the Exhibition. The institution will be known as "The Pennsylvania Museum and School of Industrial Art," and proposes to embody a museum of art in all its branches as applied to industry and technology, giving instruction in drawing, painting, wood-cutting, and designing for industrial purposes, through lectures, practical schools, and special libraries.

Technology.—The problem of mechanical puddling attracted more attention during the past year than ever before, although the results obtained in the different manufacturing districts into which rotary puddlers have been most largely introduced are somewhat conflicting, from which it would appear that the problem of puddling by machinery has not yet been wholly solved. In certain quarters of England, and in Pittsburgh in this country, the Danks furnace has given great satisfaction, and the number of furnaces has been increased. In certain other districts the experience with this system has not been so fortunate, while the Crampton system has been very successfully operated.

In England, where comparatively greater activity in the manufacture of iron during the past year prevailed than in this country, the Crampton system, in this special field, appears to have been steadily gaining in favor. In our brief allusion to the Crampton plan in last year's *Record*, we noticed that its chief features resided in the adoption of a water-jacket arrangement and the use of dust fuel; and it is very suggestive to note that in certain modified Danks furnaces lately erected in England, the leading improvement consisted likewise in the introduction of a water-jacket arrangement—approximating therefore in construction to the Crampton furnace at least in the mode of cooling by water. So far as relates to the speed of working, both systems appear to be equally good, provided the apparatus is in good condition; but in the quality of endurance under the rough usage of practice, which in this case happens to be the test of commercial success, the friends of the Crampton system lay claim to decided superiority. With regard to the relative merits of the latter system and the modified Danks furnaces just referred to, a competent authority speaks as follows: "As to what would be the relative endurance of two furnaces, each constructed on Mr. Crampton's plan with water-jacket arrangements, but one worked on the Danks system and the other with dust fuel, there are no data for actually determining; but there are certainly no reasons for believing that the results would be in favor of the former." And the same authority sums up a comparative *résumé* of the subject in these words: "Altogether, when we consider the numerous advantages attendant on the use of fuel in the form of dust, and the general excellence of the mechanical arrangements which Mr. Crampton has designed and practically carried into effect for the utilization of such fuel, we can not but regard the Crampton furnace as the most advanced solution of the problem of mechanical puddling." On all hands, finally, it is admitted that the ultimate success of mechanical puddling is assured, and that the puddling process of the future will be carried on in rotary furnaces capable of dealing with large charges, and worked in connection with plant capable of easily manipulating the large puddled balls produced.

A very useful sketch of the various methods for producing phosphorus steel (or, to use a more correct definition, phosphorus cast metal), to which we alluded in last year's *Record* in a description of the results obtained by M. Euverte at the Terre Noire Works, has been published by M. Gautier, from which it appears that considerable success has been attained. M. Gautier agrees in the general statement that phosphorus may be allowed to remain in steel without exercising any practically injurious effect upon its qualities. This metal, he remarks, can not be employed in industry except on condition that it is nearly deprived of carbon; consequently every process that yields extra-soft steel will, with inferior materials, produce phosphorus cast metal.

With regard to the future development of the Bessemer process, it may be of interest to record the following views of the same metallurgist. The Bessemer process, he affirms, is destined to lose much of its importance in presence of the certain and unlimited extension of the Siemens-Martin process, which he considers will take the lead in future, and regulate prices. It is capable of using up old iron and employing all kinds of ore, for puddling is still the only known method of practically getting rid of the sulphur and phosphorus contained in irons; while the Bessemer process, requiring as it does special grades of iron, will always have a limited application.

Perhaps the most reliable estimate of the relative merits of the Bessemer and the Siemens-Martin processes will be found in the following considerations, which embody the opinions of eminent judges: There are at least two defects in the application of the Bessemer process, or perhaps it would be better to say, two obstacles to be encountered in the practical working of the method that seem difficult to overcome. One is the impossibility of using directly pig-irons containing sulphur and phosphorus in any appreciable quantities, and the other the difficulty of controlling the quality of the product. These obstacles are too well known to need enlargement. Though the first obstacle will not in the future be so serious in America as in England, owing to the existence of large deposits of ore in various localities suitable for the manufacture of Bessemer pig, and which will doubtless be rapidly developed under the stimulus of an increasing demand; nevertheless the cost of making pig suitable for this process is so much greater than the cost of ordinary pig as to be a large item in a ton of rails. The difficulty of controlling the amount of carbon is also well known, and is a serious item in the cost. In every cast made, the amount of carbon must be determined, sometimes by chemical analysis, and again by tests of a mechanical nature.

The Siemens-Martin method has the advantage of the Bessemer in these particulars: Irons containing a much higher percentage of sulphur and phosphorus can be used, it being estimated that about two thirds of the sulphur and three fourths of the phosphorus are eliminated in the process. The crop-ends of bars, scraps, all descriptions of waste, and old wrought iron can also be utilized—in a word, grades of pig-iron that could not be used in the Bessemer process, and much that would be waste, can be readily used. In the Siemens-Martin process the quality of the product is completely under control. Should the metal at the time of testing be too soft, more pig can be added; while, if too hard, simply waiting a few minutes will correct it. The loss in the open-hearth process is considerably less than in the converter—according to Gruner, about one half.

The decided advantage of the Bessemer process is the great amount of steel produced per day, and the cheaper cost of production. In some instances the amount has, with a pair of 5-ton converters, exceeded 200 tons; while 10 tons would be a good day's work with an ordinary open-hearth furnace. With the Pernot modification of the Siemens-Martin furnace there is a prospect that this objection may be overcome. It is claimed that with Pernot's furnace 40 tons per day of Siemens-Martin steel can be produced, and we have the authority of an eye-witness for saying that the claim is well-founded. If this is true, then with six of these furnaces a product fully equal to that of a pair of 5-ton Bessemer converters could be obtained. The cost of the plant would not be more than half that of a Bessemer, the quality of the product can be controlled with ease, pig-iron inferior to that required in Bessemer could be utilized, all scraps could be worked over, and the cost of steel equal in grade to Bessemer would not exceed the latter.

In Bessemer practice the experimental trial of the hot blast is worthy of notice. The *Berg- und Hüttenmännisches Jahrbuch*, in which the record of the trial is made, states that at the Bessemer Works at Zeltweg, Germany, some fifty or more charges run with a blast heated to nearly 1300° Fahr. The result of these trials demonstrated, what had before been surmised, that a slightly-carbonaceous iron could be used in the Bessemer process with hot blast. It was likewise found that more rail-ends could be thrown in than ordinarily. Iron that with cold blast could stand only twelve per cent. of rail-ends took up with hot blast eighteen per cent. It was, however, found to be impossible to conduct the operation continuously, because of certain practical difficulties that were met with. The chief of these was the rapid wearing of the bottoms of the converters—while one would ordinarily stand about fifteen charges, it was found in these trials to be useless often after only two charges. Another difficulty was found to be the excessive heating of the parts of the apparatus in contact with the hot air. These practical troubles, it is said, caused the abandonment of the experiment, though the results obtained were sufficiently favorable to warrant the statement that the employment of the hot blast in Bessemer practice is attended with advantage, though the manipulations demand experience and practice.

During the past year the results obtained by Sir Joseph Whitworth and others in compressing steel in the liquid state by hydraulic pressure, in order to secure more perfect homogeneity of structure and increase in strength, have attracted considerable attention. In common practice, steel which is cast into ingots is more or less honey-combed by bubbles of gas distributed through the structure, which honey-combing it is endeavored to remove after solidification by the processes of cogging, hammering, and rolling the material while in a heated state. To avoid this honey-combing, some manufacturers have succeeded in producing thoroughly sound steel castings by "dead melting" the steel, employing moulds with a non-conducting lining and running the ingots with a sufficient head. We are not aware that any comparative tests have been instituted with steel so cast and fluid-compressed steel by the hydraulic method above alluded to.

The fluid compression of steel is generally admitted to have been first suggested by Mr. Bessemer, and has been very successfully in operation, with various modifications, in France and Austria for a number of years, and of late in England.

Another process for the direct production of iron from the ore was published during the past year. It is a modification of the Siemens process, the modification residing in the fact that the ore is first melted before reduction with carbonic oxide. The ore is first melted on the basin-shaped hearth of a Siemens furnace, where it is heated to the highest temperature attainable, and the reduction then effected by introducing carbonic oxide (or other reducing gases) at the working door through a hollow rabble which is moved about through the bath. By this process it is claimed that the precipitation of the iron is effected in a few minutes; and inasmuch as the gasification of carbon does not take place at the moment of reduction, it renders possible the production of a temperature sufficiently high to maintain the ore in the molten state while the reduction is taking place. The process is the invention of Director Kazetl, of the Neuberg Works, in Styria.

At the last session of Congress an appropriation was made, at the instance of the American Society of Civil Engineers, of a considerable sum, for the purpose of having a series of tests made of the strength and other qualities of American iron and steel. The commission appointed by the Secretary of War to conduct these experiments comprises the names of some of the most eminent mechanical engineers in the country. A classification of the work as the commission purposes to perform the duty assigned it has been issued; and manufacturers and others throughout the country who are interested have been invited to co-operate with the members by sending samples of their products for examination, and by imparting any information in their power. The report of the commission will doubtless possess a permanent value.

In direct connection with the above, we may likewise add that the Franklin Institute, at one of its recent meetings, appointed sub-committees on the strength of iron and steel, with instructions to make experimental trials with materials actually employed in the construction of boilers, bridges, and other structures of iron and steel.

As indicating the growing appreciation of the value of gas fuel in metallurgical and allied operations, and of the great economy resulting from its use, we would refer to the rapid increase of the introduction of the regenerative furnace of Siemens, which has of late been extended to various other industries besides iron and steel for heating purposes. The Secretary of the American Iron and Steel Association authorizes the statement that in this country there are in operation 32 crucible steel-melting furnaces, capable of producing 45,000 tons of cast steel per annum, and 14 open-hearth furnaces for the manufacture of steel by other processes, of a working capacity of 35,000 tons per annum.

Throughout the country, likewise, there are at various iron and steel works 56 of the Siemens gas-furnaces in operation, capable of heating at a single turn over 300,000 tons of iron and steel per year of 270 working days. In addition to the foregoing, there are also in successful operation a number of single and double puddling furnaces, glass furnaces, etc., and there are in present course of construction 44 furnaces, to include crucible steel-melting, open-hearth, heating and puddling furnaces. Nearly all of these have been erected within the past eighteen months.

In close relation to the above stands the use of natural gas, the largely increased introduction of which for industrial purposes throughout the neighborhood where it is found attracted great interest during the last year. The flow of natural gas from oil-wells and gas-wells has been utilized for heating and lighting purposes in several localities in Pennsylvania for some years. The credit of having first applied natural gas to metallurgical purposes belongs, so far as we are informed, to Messrs. Rogers and Burchfield, iron manufacturers, at Leechburg, Pennsylvania, who have successfully applied natural gas for about two years to all the operations incident to rolling-mill practice. The results obtained by these enterprising manufacturers were so satisfactory that wells were sunk for gas at various other localities where it was supposed to be attainable, and the flow utilized for metallurgical purposes. Wells for this purpose have lately been sunk at and near Pittsburgh, on the Ohio River at various points, and at Newcastle, in the Chenango Valley. At the latter place, a well put down by Brown & Berger is reported to have reached a good supply at a depth of 2500 feet. At Beaver Falls, Pennsylvania, a well formerly sunk for salt water was deepened several hundred feet, and at the depth of 1100 feet a strong flow was obtained, which it is proposed to introduce at once into the iron and steel works there; it has already been utilized by the file-works at Beaver Falls for heating purposes, and it is said with very economical results as to cost compared with coal, while it is far superior for use in tempering. Quite recently a company, comprising a number of prominent iron manufacturers of Pittsburgh, purchased the "great gas-well" in Butler County, Pennsylvania, with the avowed purpose of bringing the gas for use as fuel to their iron-works, a distance of about 17 miles. It is very gratifying to add that the experiment promises the best results. Pittsburgh papers, just to hand, convey the information that the laying of the pipe has been completed, and the practicability of transporting the gas for that distance (17 miles) in sufficient quantity to be of utility in extensive industrial operations, fully demonstrated. Twenty minutes after the gas was turned on at the well it was rushing through the terminus of the pipe at Ætna, and in volume sufficient to supply double the quantity of heat required at each of the iron-mills in that vicinity. The gas is conveyed through a six-inch pipe, tapped where needed with tubes of smaller calibre, and will be introduced without delay into the furnaces of numerous iron-mills. It is furthermore reported that a project is being mooted to purchase all the gas-wells in Butler County, and bring their product to the Pittsburgh manufactories. As the feasibility of the scheme has already been demonstrated, we may look for decided changes in the methods of iron-making in and about Pittsburgh and the region lying in the course of the suspected northern and southern extension of the gas-producing belt.

Other innovations in the direction of greater economy in the use of fuel for industrial operations have been introduced during the year just passed. In June last a new machine, invented by Dr. J. R. Hayes, for pressing coal-dust into fuel, was put in operation at the Harrisburg machine-shops. The apparatus employed is said to be capable of producing a ton of compressed coal in six minutes. The mechanism is described as being simple, and the operation of utilizing the coal-waste quite inexpensive. Concerning the projected works of the "Loiseau Pressed Fuel Company," to which reference was made in our last volume, nothing further has transpired during the year.

As an important item in connection with the employment of gas fuel in metallurgy, we must allude to the system of furnace-working with petroleum, which appears of late to have made substantial progress. Considerable attention was drawn to this subject during the last year by the publication of a careful investigation of the system of Dr. C. J. Eames, in practical operation at an iron-working establishment in Jersey City. The investigation was conducted by Professor Henry Wurtz, whose opinions on this subject are worthy of the greatest respect; and the conclusions which he announces bear most favorable testimony to the value of this particular process, and to the system in general, both with respect to economy of operation and quality of product. Without entering too much into details of construction, it may suffice to remark generally that in the Eames system the oil is introduced into the furnace, in any desired volume, in the form of a vapor, evolved in a so-called "Vapor-Generator," so constructed that no possible interruption can occur in its action, and that the device for securing rapid, complete, and uniformly distributed combustion of the vapor with the enormous volume of air that is required is effected by an adjustment of great simplicity and efficiency. The generator—which is the essential feature of the new process—is a cast-iron vessel, with horizontal shelves projecting alternately from opposite sides, over which shelves the oil flows downward in a thin layer, dripping from shelf to shelf. In this condition it is met by a slow opposing current of steam heated to incandescence, and kept at a pressure of about ten pounds per square inch, which passes upward into the chamber from a superheating coil placed below it, and heated by a fire. Every trace of oil is taken up in vapor, and swept onto a mixing chamber, which occupies the fireplace of the ordinary system, where it meets the air-blast. The former bridge-wall of the furnace is built up solid to the crown, except a narrow space called the combustion-chamber, which is an important feature of the device. This consists simply of a cellular tier of fire-bricks, placed on end, extending all across over the old bridge-wall. Within these cells the combustion commences, and the course of the flame is directed as may be required.

With this apparatus—the essential features of which are dwelt upon in what has preceded—Professor Wurtz affirms that the economical advantages in siderurgy, of added intensity of temperature and energy of concentration of heat, in saving of time as an element of work done, are even greater than have been contemplated by those who have fully admitted these facts on general principles; so much greater that in siderurgical practice, where the heat taken up by the iron is but a small fraction of the total heat, the calorific superiority of oil over coal, weight for weight, actively and effectively rises to the ratio of *eight* to *one*. The quality of the metal produced likewise left nothing to be desired. From the foregoing, it would appear that the system of furnace-working with petroleum has achieved a notable success.

In last year's *Record*, with reference to the progress made in the field of illumination, allusion was made to the growing popularity achieved by several processes employing petroleum in lieu of gas-coal in the manufacture of illuminating gas. It is of interest to record in this connection some reference to the "Lowe" process, the invention of Mr. T. S. C. Lowe, of Norristown, Pennsylvania, which has during the past year been introduced to light the city of Utica, New York, its practical efficiency and economy having been previously abundantly tested on the working scale at Conshohocken and Phœnixville, Pa., at which latter place it has been operated with great satisfaction for the past two years. The difficulties on the score of stratification and condensation, to which the petroleum water-gas processes as a class are supposed to be subject, appear in the case of the Lowe gas to have been, practically, entirely obviated, the product possessing a permanence and uniformity of quality, winter and summer, equal at least to coal gas. Mr. Lowe's process consists in producing from anthracite and the decomposition of steam a gas of high heating power (which he employs as a heating gas fuel in metallurgical operations), and then enriching this by means of crude petroleum when the gas is to be used for illuminating purposes. In its mechanical details the process is claimed to present marked features of difference from others. In all other methods the system of retorts or equivalent vessels heated externally has been to a large extent followed. In this, however, it has been entirely abandoned, and the materials for decomposition are introduced directly into the fire itself, by which, it is claimed, there is secured the greatest possible economy of heat. This difference is affirmed to result in important advantages. The process is concisely as follows: The anthracite is charged in a small cupola of about 3 to 4 feet in diameter, the bed of coal being kept from 3 to 4 feet deep. When fairly ignited, the base is closed, and superheated steam is admitted through tuyeres a short distance above the grate-bars. The steam in contact with the glowing coals is decomposed, and water-gas (hydrogen and carbonic oxide) is formed. This it is designed to utilize as a heating gas. To render the gas fit for illuminating purposes, a jet of crude petroleum is directed onto the surface of the burning coal, and the mixed water-gas and petroleum vapor, generated in the same chamber, and simultaneously, are passed into the secondary chamber of fire-brick, where they are subjected to a still further increase of temperature, which treatment serves to render the product permanent. Thence it passes through the washing and condensing apparatus, onward through the lime-boxes to the holder. The charge which has been used in some of the works where this process has been introduced has averaged 280 gallons of crude petroleum and 3600 lbs. of anthracite for the production of 70,000 cubic feet of illuminating gas of a quality not less than 20 candles, and at an average cost of 56 to 60 cents per 1000 feet. At Utica, which is the largest place yet lighted by this system, it is expected to reduce the cost of manufacture—maintaining the same quality as above named—to 50 cents (or less) per 1000 feet. At these works, which have lately gone into operation, two men, at laborers' wages, make all the gas required by the city, the coal gas having been entirely superseded.

The performance of this and similar systems is deserving of far more attention from the public than it has yet received.

Experiments have lately been made in Berlin with the view of determining the adaptability of the electrical light for military signaling. The light employed—which was one of great intensity—was so arranged with an inclosed mirror that the rays were projected against the clouds, which, serving as a screen, repeated on a gigantic scale in the sky the signals made in front of the mirror.

It is likewise of interest to record in this connection that M. Gramme has communicated to the French Academy the fact that he has effected substantial improvements in the construction of his dynamo-electric machine, by the employment of the thin-plated magnets suggested some time since by M. Jamin. By their use he is enabled greatly to augment the intensity of the currents. The new machines have only one central ring instead of two, two electro-magnets in place of four, their weight and size are greatly diminished, and their capacities notably increased as compared with the earlier machines.

We recorded last year the invention by Messrs. Edison and Prescott of the ingenious quadruplex telegraphic instrument, by means of which two messages may be sent in the same direction and two others in the opposite direction simultaneously upon the same wire. A number of these instruments have been introduced during the past year, and with marked success. In this volume we may record the first public trial of a discovery in telegraphy which promises even more wonderful results, and by which it is affirmed, on good authority, that at least sixteen messages can be sent simultaneously over a single wire. The new system is the discovery of Mr. Elisha Gray, of Chicago, and is termed "the Electric-Harmonic Telegraph." The invention, which has been practically developed during the past year, is at present being tested upon the lines of the Western Union Telegraph Company.

Mr. Gray's system of multiple transmission is founded upon the principle that composite tones are as readily transmitted by a wire as single notes. The depression of each key sets a self-vibrating electrotome in operation, which is adjusted or tuned to vibrate at a certain rate, differing from that of any of the others, when under the influence of the electro-magnet controlled by its corresponding key. These several sets of electrical vibrations are transmitted through the circuit without interfering with each other, in the same way that any number of different sets of sound waves may pass through the air without mingling or interfering. At the receiving station each instrument is so adjusted as to respond to its own special sets of waves, or vibrations, without regard to others. By breaking and closing the circuit upon the transmitting electrotome, so as to form telegraphic signals, these are transmitted and taken up by the corresponding receiving apparatus. Concerning the experimental trials which are being made with this remarkable apparatus, we learn that, while certain minor difficulties were shown to exist, which it is anticipated may readily be overcome by suitably modifying the transmitting apparatus, enough has been demonstrated to show that the invention is destined to become a very useful and important one. It may be remarked, incidentally, that one of the peculiarities of Mr. Gray's system lies in the fact that while sixteen persons may be using the wire, none of their messages need interfere with the others, or become known to any of the others save the sender and the designated receiver. On September 11th an experiment test of the apparatus was made on a wire between New York and Boston (240 miles in length), over which four separate messages were simultaneously transmitted from Boston, and copied from four sounders by a like number of receiving operators in New York. It must not be inferred that the number of communications that may be carried over the same wire simultaneously is limited to sixteen, since in theory the system knows no limit as to number, and in practice the extent to which the multiple transmission is carried will depend solely on the perfection of the mechanism. We await the future development of this invention with much interest.

A brief abstract of the facts relative to the industrial employment of paper may not be out of place, in view of the increasing importance of the subject.

It has long been known to chemists that certain substances will act powerfully upon cellulose (or vegetable fibre), and a number of processes have been devised for utilizing these facts in the arts. The peculiar compound known as cupro-ammonium appears to be an admirable solvent for cellulose, dissolving it completely without in the least destroying its properties. From this solution the cellulose can be again precipitated in a perfectly pure state by the employment of the proper re-agents. This observation has already been utilized in the manufacture of a number of useful articles from woody fibre, paper stock, seaweed, and the like. It has been employed in making paper impermeable to water, the sheets being simply immersed for a few seconds in the metallic solution, then passed between rollers and dried. Paper thus treated becomes quite impermeable and leathery, resisting even the disintegrating action of boiling water. By passing a number of sheets together through the rollers, an extremely thick and tough fibre is produced, which forms an excellent substitute for leather, and for which doubtless a great variety of uses will be found. The cupro-ammonium treatment of paper has already been successfully applied to the production of roofing, gas and water pipes, hats, boats, clothing, etc.

Other processes for the treatment of paper have been devised, and of late to some extent utilized in the arts. The well-known paper-parchment, which has only of late years come to be properly valued, is prepared, as was discovered by Hoffman, by passing unsized paper through strong sulphuric acid. By this simple treatment it is converted into a substance closely resembling parchment in its appearance and behavior, being not only remarkably strong, but also quite impervious to water, hot and cold. A number of metallic salts, of which we may mention chloride of zinc and chloride of aluminum or tin, also act powerfully upon cellulose. Paper passed through a solution of either of these substances is affected in the same manner, and perhaps quite as decidedly, as when treated with cupro-ammonium; and of the article thus prepared quite a variety of applications has been made. When freshly prepared, this article can be pressed into moulds, and made to assume any desired form by this and other means. There have been made combs, knife, fork, and brush handles, gas and water conductors, and a great variety of articles of utility or ornament. Even car-wheels have been made from it by strongly compressing a number of sheets together, and, if report has not exaggerated, their behavior in practical use is excellent.

Carton-pierre (paper-stone), another material prepared with paper, has of late attracted much attention. As may be inferred from its name, it is one of the many varieties of *papier-maché*, and is claimed to partake of the nature of stone in appearance and durability, possessing at the same time a fibrous quality and a certain elasticity, so that it might properly be described as a manufactured material taking an intermediate place between stone and wood. It is therefore as a substitute for these two materials that it has done most service, finding a natural and inviting field in all classes of architectural enrichments, where boldness and beauty make strength and lightness necessary to permanence and safety.

While the cost of its constituents prevents its competing with stone, slate, or wood in their plain or unshaped conditions, it can, however, be produced in any ornamental form very much cheaper than the same article could be manufactured from the articles named, the pattern or model of the article required being of course a prerequisite. In general, the material is composed of carbonate of lime and paper, combined with animal glue, to which, however, various other articles are added, such as flour, oil, rosin, siccatives, etc., depending upon the requirements of the thing to be produced. It is worthy of note that it has superseded plaster of Paris for architectural decorations in many of the large cities of Europe, and especially in Paris; the plain walls and lines being of plaster and the adornments in *carton-pierre*.

The fact that figures of great size and very considerable strength can be produced in complete relief and very light, has recommended its introduction very largely into public buildings. It is but a few years since it made its first appearance in this country as a manufacture, but native ingenuity had scarcely touched it before it showed signs of improvement, and new fields for its utilization were opened. It has been lately produced of a nature that will permit it to successfully resist heat almost equal to slate, and without that danger of splitting in strata that renders the use of ornamental slate objectionable; besides which the *carton-*

pierre possesses a toughness to which slate is a stranger. For this reason it has almost entirely monopolized the ornamental work of mantels; besides being extensively employed for columns, pedestals, bases, clocks, etc., marbleized in the same manner as slate and with as fine a finish.

As made by the American process, it paints better than wood; bronzes almost equal to metal; marbleizes with a finish equal to the natural stone; and, what is especially worthy of mention, it is said to gild better than any other known material employed in the arts, in consequence of which it has, within the short space of six years, completely supplanted every competitor in the field of ornamentation for mirror-frames and gilt-work wherever it has been brought into competition with them. Its future applications, in connection with *papier-maché*, are almost unlimited, and together they are quietly working quite a revolution in certain directions; a fact that will become more and more apparent as timber disappears, and increasing remoteness lends addition to its value.

In connection with the processes in vogue for the injection of timber with preservative solutions, we will allude to what appears to be a decided improvement on the Boucherie system—hitherto the best—and which was brought to public notice during the past year. In this process—the invention of G. B. Smith—a ring of steel having a knife edge is partly driven into the butt of the sawed log, upon which is fastened a cap of cast iron by rods and chains passed over the other end, the inner face of the cap being planed so as to afford a water-tight joint with the outer flat side of the inserted ring. The cap is in connection with a pump, by means of which the preservative solution (any that may be desired) is forced by hydraulic pressure through the natural sap channels of the wood, driving out the sap before it until it makes its appearance at the other end, when the log will be found to be most thoroughly injected, from centre to circumference, with the liquid employed. The superiority of this method of injection over the numerous processes involving the employment of closed vessels in combination with high temperatures and pressures, which can only effect at best a partial impregnation of the wood, and are necessarily attended with a greater or less amount of mechanical weakening and rupture of the fibre, will be apparent, while its great simplicity and directness will commend it to general favor.

A French inventor, M. De la Bastie, has succeeded in producing, by a simple process, specimens of glass, perfectly clear and transparent, but extremely hard and durable. He calls the product *verre trempe*, or tempered glass. The liquid in which the glass is tempered is said to be a compound of melted wax and resin and various oils, the ingredients being mixed in different proportions according to the purpose for which the glass is intended. Into this liquid, heated to the desired temperature, the glass, which has reached the required heat in the oven, is pushed out upon a metallic slide, and descends by it upon an inclined plane placed in the vat. The depth to which it is allowed to sink in the oil is regulated by a species of brake, which stops at the proper point. It is allowed to remain in the bath for about a minute, when a self-acting rake draws it into a metal frame, which is removed from the vat, and the glass is allowed to cool. Meantime more glass has taken its place in the vat, the operation being thus made continuous. This tempering process is said to add decidedly to its value, and most extraordinary accounts of the resisting qualities of the *verre trempe* have reached us; on which account the process promises to become of great importance. In this connection it may be added that, while the idea of tempering glass is not a new one, attempts having repeatedly been made at glass-works to effect it, M. De la Bastie appears to have been the first who has succeeded in solving a number of practical difficulties, which appear to have rendered previous experiments of this kind but indifferently successful.

The investigations of Professor Kolbe, of Leipsic, brought into great prominence last year a new antiseptic agent—Salicylic acid—which has demonstrated itself to be of great value in medicine and in the arts. Salicylic acid behaves in nearly every respect like carbolic acid, for which it is recommended, and already largely adopted as a substitute. It appears to be equally powerful with the latter in arresting fermentation and putrefaction, in addition to which it possesses the advantages of being tasteless, odorless, and non-poisonous. As a substitute for carbolic acid in medicine and surgery, it has already achieved great popularity.

A number of *mechanical* novelties are worthy of mention. Of these, perhaps the most interesting is the application of the sand-blast for producing upon plated-ware or silver a lustreless, very finely grained surface (called by the trade a satin finish). The usual method of effecting this is by a number of swiftly revolving brushes, made of fine wire. The adaptation of the sand-blast for this purpose is said to be perfect. The operation is exceedingly rapid, as the article has only to be turned so that the blast strikes for an instant upon the required portions, the article being covered by a rubber screen of suitable pattern.—A self-feeding nail machine, making sixpenny nails at the rate of 300 to 360 per minute, has lately been put in operation at the nail factory of the Albany Iron-works.—Mr. M. Orum, of Philadelphia, has invented a very simple and perfect method of bending metal pipes, which consists in the employment of a closely coiled spiral of square steel wire, of a diameter suited to that of the pipe to be bent. This spiral is inserted into the pipe, and acts as a flexible mandrel. When the pressure is brought to bear on the pipe, this flexible mandrel affords it an equable though elastic support, and permits the bend to be accomplished in the most perfect manner, and in a fraction of the time required by the method commonly used.—The so-called "Brayton Motor," which attracted considerable attention during the year, is an ingeniously contrived engine, operated by the expansive force produced by the combustion of a mixture of petroleum vapor (or gas) and air. It differs in several essential features from other gas and vapor engines. To avoid the inconvenience and loss of time involved in fixing upon a lathe chuck, in the ordinary way, certain special kinds of work, such as thin steel disks or small circular saws, the ingenious artifice of converting the chuck into a temporary magnet has been resorted to with great success. Under these circumstances, the steel pieces when placed on the face of the chuck are held there firmly by the magnetic attraction, and when finished can readily be removed by breaking the galvanic circuit and demagnetizing the chuck. The same principle has been applied to machine tools for holding articles of large diameter and weight.—The National Tube Works Company, in addition to making wrought-iron pipe of unusually large size, has introduced the novelty of an enameled water-pipe, which they now manufacture of all sizes from one eighth of an inch to sixteen inches in diameter. It is claimed for this iron coating that it has been subjected to the most severe chemical tests successfully; that it will protect the metal effectually from rust or corrosion by acids; and that it is indifferent to the action of heat and cold, boiling water, etc. For domestic water supply, it would appear to possess decided merits.—In addition to our allusion to the discovery of the great ore-body (or bonanza) on the Comstock lode, it is of interest to mention the opening of a mine yielding gold, silver, copper, and lead near the town of Newbury, Essex County, Massachusetts. Several shafts are down, meeting an abundance of ore, much of which is of high grade.

As the space at our command is limited, we may add, in conclusion, it has been necessary, in our general *résumé*, to curtail our remarks upon many important topics, to simply allude to others, and to omit all mention whatever of numerous items of general interest. To a large extent, however, this fault is remedied by the addition of the copious body of descriptive items, which will be found under suitable classifications in another place.

TECHNOLOGY.

In the field of *Chemical Technology* we may record that Kuhlmann has devised the following method of effecting the regeneration of the manganese residues in the manufacture of chlorine.

The crude chloride of manganese solution is mixed with chalk (in order to get rid of iron as a carbonate), and then with milk of lime, to convert the chloride of manganese into oxide. This oxide, after careful washing, is dissolved in nitric acid, the solution evaporated, and the dry residuum heated in retorts to a temperature sufficiently high to drive off the nitrogen as hyponitric acid and nitric oxide, but not so high as to decompose the binoxide that will have been formed. These vapors are led into and absorbed by the hydrated oxide of manganese obtained as above detailed; the salt resulting is calcined, and the terminal stage of the above-described operation gone through with it, and so forth. In this manner the process of regeneration can be carried on for an indefinite period, with very little loss of nitric acid.

The presence of lime in the oxide of manganese increases the percentage of loss of hyponitric acid, to avoid which the inventor recommends the employment of just so much lime as will be necessary (the proportion by equivalents) to oxidize the chloride of manganese. By the use of this process Kuhlmann claims to be able to regenerate 88 per cent. of the superoxide of manganese. By the process of Weldon, which is much simpler (vide *Annual Record*, 1873, p. cxxx *et seq.*), some 70 per cent. is claimed.

Hargreave's improvements in the alkali manufacture are said to be making rapid progress, while the ammonia process is not found to work so well as was at first anticipated. Grüneberg & Vorster, of Cologne, have patented a process of obtaining caustic soda by passing superheated steam over a heated mixture of common salt and of alumina or its hydrate.

Dr. Crookes affirms that the application of Sprengel's device of employing atomized liquids in operations where a liquid is made to act as an absorbent of a gas has effected a material improvement in the production of sulphuric acid. In the ordinary process of manufacture, the sulphuric acid as contained in the chambers contains about 50 per cent. of water, which was once steam, and was taken as such from the steam-boiler. Before condensation of this steam occurred, this steam occupied a certain space, and moreover helped (on account of its heat) to expand the bulk of other gases used in the formation of sulphuric acid. In winter time the yield of acid is better, and the consumption of nitre less than in summer; and the greater the chamber space (*i. e.*, the smaller the volume of gas allowed to pass the chambers in a given time), the less will be the comparative consumption of nitre, and the easier will be the conversion of all sulphurous into sulphuric acid. Hence, adds Dr. Crookes, as the lowering of the temperature of a gas implies the shrinkage of its volume, both of which favor the process of sulphuric acid-making, Mr. Sprengel commenced to manufacture sulphuric acid by means of what has been called "pulverized or atomized water or spray," which he injects into the chambers as a substitute for steam. This effects, first, a saving of fuel equal to the amount which is required to convert this pulverized water into steam; and, second, a cooling of the chambers equal to the loss of the amount of heat which would have been generated by the combustion of the coal thus saved. To form this spray an atomizer is employed, in which a small body of steam is made to escape from a platinum jet, under a pressure of about two atmospheres, into the centre of a flow of water. With this device, twenty pounds of steam will convert eighty pounds of water into the finest spray. The jets are arranged in the sides of the chambers about forty feet apart. They are supplied with water from a tank above, while the steam is taken either from the steam-pipes already existing between the chambers, or from smaller ones put in their place. The saving in coal effected by the introduction of this simple device is estimated by a large manufacturing company that has employed it for some time to be two thirds of the quantity formerly burned; or, to estimate it differently, the savings in steam, acid, nitre, and labor during three months amounted to five shillings per ton of acid.

The following bleaching processes are recorded by Braekebusch, who refers to the fact that the methods generally in use are not satisfactory. (1.) Cotton and linen tissues are brought in contact with oxide of zinc dissolved in lye of potash or soda. In this process there is no bleaching, properly so called. The oxide of zinc combining with the textile fibre merely masks the natural color of the latter, or perhaps forms colorless compounds with the coloring matters present. In connection therewith, it is noted that the alkaline liquids employed may affect the tissues. (2.) It has been proposed to bleach wool and silk by immersion for an hour in a solution of one part common salt, and one part oxalic acid, in fifty parts of water. The influence of the oxalic acid is certain, though unexplained. (3.) Tessié du Motay takes about equal parts of the permanganate of soda and of sulphate of magnesia, and dissolves them in lukewarm water. The tissues, previously freed from grease, are immersed in this bath until they are covered with a brown coating. They are then placed in a bath of sulphuric acid at four per cent., and rinsed after the brown matter is removed. They may be finally passed through sulphurous acid. (4.) Ramsay's bleaching bath is formed by sprinkling with water equal parts of chloride of lime and sulphate of magnesia, by which process the hypochlorite of magnesia is produced. This last process is highly spoken of.

Upon the subject of ozone, Dr. Hofmann offers this stimulus to investigators in his late "Report on the Development of the Chemical Arts during the last Ten Years:" "How great would be the influence of a cheap source of ozone upon manufactures appears at once from the fact that in the nascent state this body oxidizes nitrogen to nitric acid. The presence of the latter body in thunder-rain has long ago been found to result from this circumstance. The manufacture of ozone would therefore involve nothing less than the synthesis of this important mineral acid, obtained hitherto only from nitre. That in grass-bleaching and in disinfection by means of ethereal oils we have from time immemorial made use of ozone—generated in the one case by the growth of grass, and in the other by the hydrocarbons —can only serve to intensify our longing for the technical production of ozone." Dr. Hofmann refers also to the fact that the first patent for the application of ozone was recently granted in England, for the purpose of forming acetic acid from alcohol without fermentation. The inventors (Turner and Vanderpool) obtain ozone by blowing air through a flame, and bringing it in contact with a current of alcohol. A very similar process for obtaining ozone was patented in this country, it may be added, by Dr. Loew, but no account of its practical application has thus far transpired.

The *Chemical News*, in its notes from foreign sources, affords the following information concerning Hofmann's process of utilizing iron pyrites. It is well known that the sulphur employed in the manufacture of sulphuric acid was formerly obtained from Sicily in its native state. In consequence, however, of the considerable increase in the export duties levied thereon during the last twenty years, the attempt was successfully made to supersede the sulphur by iron pyrites. The extraction of these pyrites is only found profitable where they occur in large masses. The residues likewise contain such large proportions of iron (about forty per cent.) as to entail large losses therefrom by the works, while the quantities of the same are so great as to render it difficult to find room for them. Dr. Hofmann has devised the following process for utilizing them on a large scale: The residues undergo a systematic washing, the temperature of the water being about 40° C. (104° Fahr.). To the washings thus obtained salt is added in the proportion of one equivalent for each equivalent of sulphuric acid present in the liquid. The result is sulphate of soda, which is separated by cooling and crystallization. This product has numerous industrial applications, especially in the glass trade and in the soda manufacture, and it is obtained in the present case in quantity sufficient to cover the cost of all the operations. The mother-liquors remaining after the sulphate of soda has been separated contain zinc chloride, salt, sulphates of iron and of zinc, and a further quantity of sulphate of soda. By concentration to 54° B., the various salts are deposited with the exception of the zinc chloride, which may then be separated. It has several well-known industrial applications, and commands a good price. Or it may be worked for metallic zinc, by being first treated with lime to convert it into zinc oxide.

The residue containing the iron originally present in the pyrites, still impurified with some sulphur, is dried for some days in the open air, when the bulk thereof crumbles to powder, though there remain also compact fragments. With regard to these masses, Dr. Hofmann has observed that the pulverulent portions are almost free from sulphur, which is almost completely contained in the more compact fragments. A simple process of sifting suffices to separate the portion free from sulphur, which is then ready for metallurgical treatment as an iron ore.

Professor Henry Wurtz has succeeded in devising a very practical gravimetric method of gas analysis as a substitute for the volumetric methods generally employed. The method which he recommends — and which he has developed with special reference to the investigation of illuminating gases—is founded on the general principle of submitting a slow current of the gas to be investigated to the action of a series of agents, so selected and combined as to absorb and separate in succession, each by itself, the different proximate constituents of a gaseous mixture, converting each into a solid or liquid form, in which condition they can be weighed on a balance. Professor Wurtz alludes in his memoir to the fact that gravimetric methods for gas analysis were successfully employed by chemists some thirty years ago, and expresses his surprise that so little has been done to develop their capabilities. The general outline of his method is about as follows: In a crude coal gas, as drawn from the hydraulic main, the gas-chemist should be able to separate and determine with precision the following: (1) Tar, suspended in the form of spray; (2) Water, do.; (3) Water, as vapor, dissolved in the gas; (4) Naphthaline (condensible); (5) Other condensible hydrocarbons; (6) Smoke and soot (with dust); (7) Ammonia; (8) Carbonic acid; (9) Sulphureted hydrogen; (10) Carbonic oxide; (11) Oxygen (intermixed air).

Of these eleven proximate constituents, Professor Wurtz affirms that he has succeeded in separating with very satisfactory sharpness Nos. 1, 2, 3, 6, 7, 8, 9, and 11, eight in all, besides approximating to No. 4 the naphthaline in excess. Nos. 5 and 10 are still subjects of experiment. The following are the devices and manipulations employed: First. Arresting suspended matter by means of empty dry flasks, and straining through cotton previously desiccated. Absorbing next the ammonia, by means of re-agents which act on no other ingredient. Next, drying the gas with calcium chloride, which, ammonia being absent, may now be done. Next, taking up the sulphureted hydrogen by a normal metallic salt, so selected or so managed as to give up no water or acid vapor to the desiccated gas. Next, using sodic hydrate to absorb the carbonic acid, with certain precautions. Next, alkalized pyrogallol, or other suitable agent, to absorb oxygen, arranged so as to lose no water. The final (rough) measurement of the gas is then made at an observed temperature by a gas-meter. The whole process is finally completed by a process of distillation, either at the ordinary or higher temperature in a current of the same gas analyzed, that has been subjected to similar treatment, and thus freed from all the ingredients to be separated from each other. After final weighings, the correct initial volume of the gaseous mixture is calculated from certain formulæ derived from the crude meter-indications and the final weighings. For further details, we refer our readers to the memoir in full (vide *Journal of the Franklin Institute*, Vol. LXIX., p. 146 *et seq.*).

Schering affirms that the burning of glycerine may be readily effected in any form of lamp which permits the flame to be brought directly above the surface of the combustible. A long wick will not afford a steady flame, because of the sirupy consistency of the glycerine. The flame of glycerine is, like that of alcohol, very slightly luminous; and as the latter is of great utility as a solvent, Schering was induced to experiment with the glycerine flame, with the view of substituting the latter for the alcohol flame for laboratory and other purposes. The results obtained were quite satisfactory.

The assertion of Raoult, that pure cane-sugar in aqueous solution, and with the complete exclusion of air and ferments, would gradually undergo inversion under the influence of light, has been called in question by Kreussler, who has repeated the experiment with every possible precaution. The last-named chemist asserts that a pure sugar solution, kept in glass tubes, the open ends of which were drawn out and sealed with the blow-pipe, after the air contained therein had been completely driven out, failed to respond in the slightest degree to Fehling's test for glucose. Where the air had not been completely excluded, however, the contents of the tubes upon examination indicated the conversion of from 52 to 90 per cent. of the cane-sugar into grape-sugar.

Albumen for printing purposes is said to be becoming scarce, and a new source of supply is greatly needed. The debasement of silks by foreign admixture, if we may infer from the comments of journals devoted to textile interests, has of late reached such a height as to promise shortly to rival that of a class of cotton-goods which have added largely to the notoriety, if not to the fame, of one of the manufacturing centres of England. A writer to one of the French journals shows that the weighting of black silks—which began with the modest aim of making up for the loss sustained in ungumming—is now carried to the extent of 100, 200, and 300 per cent. This increase of weight is effected by treatment with salts of iron and astringents, salts of tin and cyanides. The bulk is augmented proportionably to the weight. The same writer points out very clearly the evils attending this excessive adulteration. The chemical and physical properties of the silk thus treated are materially modified. What is sold as silk is, in reality, a mere agglomeration of heterogeneous matters devoid of cohesion, held together temporarily by a small portion of silk. The strength and elasticity of the fibre are likewise reduced. From being in its natural state one of the most stable of substances, and but slightly combustible, in its adulterated state it burns like tinder if touched by a flame. It is likewise affirmed to be liable to undergo spontaneous decomposition, and to absorb gases with the evolution of heat which sometimes leads to actual combustion. The adulterated silk when burning scarcely gives off the characteristic odor of animal matter.

It is of interest to supplement our notices in last year's *Record* of the artificial production of vanillin—the active principle of the vanilla bean (which is now a commercial operation)—by reference to a suggestion for obtaining it largely by another process. In several manufacturing operations pine-wood is treated in iron boilers, under high pressure, with a solution of caustic alkali. The resulting liquid contains various salts of soda, and, if the temperature has not been too great, among them the soda salt of vanillin. Experiments made with the view of establishing this fact are conclusive, its presence being demonstrated by the presence of an intense vanilla odor, which becomes more prominent when the liquid is treated with an acid and left standing for several days. It has thus far, however, been found impossible to extract the crystallized vanillin from the above-named liquid, though in all likelihood this consummation will not be long delayed.

M. Gerard gives the name of Apparatine to a colorless, transparent substance which he obtains by heating starch, or substances rich in starch, with caustic alkali. The product resulting from this treatment is said to be excellently adapted as a dressing for all kinds of textile fabrics—cotton, woolen, or silk—to which it imparts a velvety gloss impossible to obtain by any other mode of treatment.

M. Paulet's observations upon the chemical operations involved in the preservation of timber, contribute materially toward the rational explanation of conflicting and often contradictory results obtained in practice. This author's investigations—lately placed before the French Academy—were devoted specially to the examination of the destructive action which takes place in wooden railway sleepers injected with sulphate of copper. It is generally held that the protective action of metallic salts is due to their combination with the ligneous tissue, and especially with the nitrogenous matter, which is rendered insoluble and poisonous to living beings. This operation the author claims to be insufficient. He affirms, from his studies of the action of metallic salts, and especially of sulphate of copper, upon the nitrogenous matter of wood, that the albumino-cupric precipitate is not absolutely insoluble in water, and that it is especially soluble in water containing carbonic acid. The nitrogenized matter in wood is partly soluble and partly insoluble. The soluble albuminous portion is fixed by the metallic salt, which combines also with the insoluble nitrogenous matter. The water, especially if charged with carbonic acid, destroys and removes this metallic compound; in proof of which the author gives a number of examples, which show that the copper gradually passes out of the combination and disappears altogether, giving place to the carbonate of lime. The process is explained to be as follows: The carbonate of lime contained in the ballast is slowly dissolved under the influence of the rain-water, and penetrates gradually into the wood, substituting the copper. So long as the copper remains in its original combination, its preservative action continues. The carbonate of lime is not a septic agent, but it eliminates the preservative body from its compounds, and restores the matter to be preserved, if not to its natural state, at least to one which facilitates the access and the action of destructive agents. This theory is confirmatory and explanatory of the fact, long established by observation, that railway sleepers, etc., are destroyed most rapidly in calcareous soils; and the affirmation of the imperfect insolubility of the albumino-metallic precipitate, is additionally confirmed by the fact that the injection of timbers with metallic compounds has been found to afford but little protection to the same where they are immersed in fresh or salt water.

Some further comments on the methods of injecting timber with preservative compounds will be found under the department of General Technology.

It is of importance to record that Coupier's process for producing aniline colors without the employment of arsenic is being largely introduced. It appears that Coupier some time ago succeeded in producing fuchsine by the action, at a suitable temperature, of hydrochloric acid and iron in small quantities on pure aniline and nitrotoluol. Although it was demonstrated that the aniline red obtained by this method was identical with that usually manufactured, and that the yield was greater than where arsenic acid was used, the process was until lately very sparingly introduced on the commercial scale. Recently, however, we learn, the *Gesellschaft für Anilin Fabrikation* of Berlin has erected new works, where no arsenic acid is used in the preparation of colors. Not only fuchsine, but all the colors derived from it, are made, and all are warranted to be free from this poisonous agent. The company is producing from 200 to 300 kilogs. per diem, and the product is affirmed to be not only purer, but stronger than that made from arsenic acid. Being entirely free from this poisonous substance, these dyes are suitable for a great variety of industrial uses where the others have been found to be dangerous. Upon this subject the *Chemical News* expresses the hope that, the commercial success of the innovation being demonstrated, other manufacturers of these dyes will adopt the new method, and relinquish the old arsenic-acid process, which, apart from the inconveniences it has caused both manufacturers and consumers, has led to many lamentable accidents.

Eosin (from ἔως, *dawn*) is the name by which a newly introduced dye-stuff has been designated. In its solutions and upon silk it is characterized by exhibiting a gorgeous fluorescence, in which the beautiful tints of rose and garnet red predominate. It is brought into commerce in the form of a brown red powder, with a greenish, metallic sheen. It is soluble in water and in alcohol.

Delachanal and Mermet have devised a lamp for photographic purposes which effects the continuous combustion of carbon-disulphide and nitrous oxide. Riche and Bardy have investigated the photo-chemical intensity of various flames, and give the following tabulation as the correct expression of the relative value of several lights examined, in which the intensity increases with the figures:

	Relative Chemical Energy.
Drummond-light	3
Zinc burning in oxygen	4
Magnesium lamp	5
Flame of nitrous oxide and carbon-disulphide vapor	6
Flame produced by leading nitrous oxide into that of carbon-disulphide burning in an open dish	6–7
Flame produced similarly by oxygen	7
Oxygen directed upon the flame of burning sulphur	8

From the foregoing it appears that the light produced by the combustion of sulphur in oxygen is possessed of extraordinary chemical energy, and may be applied to photographic uses with excellent effect.

Stein, in a communication upon the subject of normal weights and measures of rock-crystal, remarks that Kekulé pointed out, some time ago, the fact that all amorphous bodies, whether produced by casting, rolling, hammering, or stamping, are possessed of the tendency to go over into the crystalline condition. The molecules of such substances he regards as being in abnormal positions relative to each other, and the striving toward crystallization is the natural effort to assume the position of equilibrium. For these reasons, Kekulé objected to normal weights and measures made of metal, affirming that they could not be relied upon to remain constant; while, on the contrary, this objection would not hold good of such normals when constructed of a crystallized substance, as, for example, of rock-crystal. Recognizing the validity of the foregoing arguments, the author has had such weights and measures cut at Oberstein. To produce the measures, the pieces are cut exactly parallel with the optical axis of the rock-crystal, so that the main axis of the crystal coincides with the median line of the rod. The same rule is likewise observed with the weights, by which an unequal expansion is avoided. These normal weights and measures are manufactured at Oberstein by H. Stern, who has likewise devised a method of attaching the pieces to each other, when measures of considerable length are required, in such a manner that any alteration of the scale of parts is not possible, and the correctness of the division, as also of the total length, may be under control. For these weights and measures a number of advantages are claimed. The considerable hardness of the rock-crystal (7) protects the weights from abrasion by usage, to which objection all weights of metal are open. The rock-crystal is even more indifferent to the action of acids and alkalies than platinum, while it is utterly indifferent to oxidation, to which weights of metal are more or less liable. Moisture has no effect upon it, since it is not hygroscopic. Rock-crystal, as compared with the metals, has a very small co-efficient of expansion, on which account the errors arising from variations of thermometer and barometer are reduced to a minimum. The weights are not objectionable on the score of expense, their cost being quite moderate. As produced by Stern, the larger weights, from 50 grammes to 1 gramme inclusive, are made of rock-crystal, the pieces having the same form as the commonly used weights of gilded brass, while the weights under 1 gramme are made as usual of platinum. Fresenius, who has examined and employed them, declares them to be admirably adapted for analytical work.

Lewin impregnates sandstones with a solution of sulphate of alumina, which he follows with water-glass. The stones thus impregnated may be polished and appear like marble. They resist the action of fire and of the atmosphere, and are well adapted both in appearance and durability to take the place of marbles. By preparing them at a high temperature the stones take on a species of glaze, which may be decorated with a variety of colors to imitate colored marbles and the like.

ANNUAL RECORD

OF

SCIENCE AND INDUSTRY.

1875.

A. MATHEMATICS AND ASTRONOMY.

THE EARLY USE OF THE DECIMAL POINT.

Mr. J. W. L. Glaisher, in some remarks on the history of the introduction of the decimal point into arithmetic, concludes that this invention must be attributed to Napier, the immortal inventor of logarithms. The earliest work in which the decimal separator was employed seems to be Napier's posthumous work in 1619, at which time it appears that he was aware of all the attributes that enable the decimal point to complete systematically our method of notation. About the same time Briggs employed a bent or curved line, for which, in printing, he substituted merely a horizontal bar drawn under the figures that were to be considered as decimals; but Napier himself has left so many instances of the actual use of the decimal point as to render it pretty certain that he thoroughly appreciated its use.—*Rep. Brit. Assoc.*, 1873, 12.

TABLES OF ELLIPTIC INTEGRALS.

The committee of the British Association, which has for some years had in hand the preparation of a list of tables and the calculation of new mathematical tables, report the completion of the tables of the elliptic functions, on which six or seven computers have been constantly engaged for two years past, under the superintendence of the Messrs. Glaisher.

These tables give the four theta functions which form the numerators and denominators of the three elliptic functions. The calculations relating to these functions have been carried to ten decimal places, and the printed results will occupy about four hundred pages.—12 *A*, X., 372.

NEW FORMULA FOR DETERMINING THE ALTITUDE FROM BAROMETRIC OBSERVATIONS.

M. St. Robert, of France, has published the concluding volume of his memoirs, among which we notice a new formula for determining the altitude for barometric observations. This formula embodies the results of Glaisher's balloon observations.

THE REDUCTION OF ELLIPTIC INTEGRALS.

From a mathematical paper by Meissel, Professor in Kiel, we take the following theorem, whose enunciation will be of interest to mathematicians. He states that in a great number of cases he has been able to represent the complete elliptic integral of the second order by means of algebraic formulæ, and demonstrates, in general, that the complete integral of the second order can be converted into a complete integral of the first order.—*Archiv der Mathematik*, LVI., 337.

THE TRISECTION OF AN ANGLE.

The problem of the trisection of a circular arc has lately been solved by Dr. Hippauf in a simple manner by means of an auxiliary curve, which may be designated as the conchoid on a circular base. This circular conchoid is the locus of a series of points found by drawing through one extremity of the diameter of a circle a series of lines, and finding, upon each, that point which is at a distance from the circumference of the circle equal to the radius. Having described such a circular conchoid for the circle an arc of which we wish to trisect, we draw the chord belonging to the latter arc, and then through the origin of the conchoid a parallel chord; this latter is equal to the chord of the third part of the arc to be trisected. Three other methods of effecting this trisection are also given by Hippauf by the aid of the same curve; and many other curious properties are found by Professor Sidler, who has shown that this conchoid may also be described as the locus of the feet of a series of perpendiculars let fall upon all possible tangents to a circle, from a point outside the circle, and at a distance from the centre thereof equal to its diameter. The conchoid is likewise easily described graphically by a point fastened to a given circle which rolls around a fixed circle, provided that the two circles have the same diameter, and that the point be fastened to the rolling circle at a distance from its centre equal to the diameter thereof.—*Mitth. der Naturf. Gesell.*, *Berne*, 1873, 31.

STANDARD TIME IN PITTSBURGH.

The question of the regular distribution throughout the community of standard uniform time has been well tested by Professor Langley, of Pittsburgh, who, during the past five years, has steadily extended the system of telegraphic connections between the astronomical observatory of that city and the railroads that centre therein. The magnificent new City Hall has in its turret a large tower clock, built by the Messrs. Howard of Boston, which by electrical connections is made to beat, second by second, in perfect unison with the standard clock at the observatory. A person at the latter building can, if necessary, even adjust the tower clock by telegraph, and can at any moment ascertain whether its indications are correct or not. The large bell of the tower is struck with the utmost accuracy at noon, and at every third hour throughout the day and night, and the public appreciation of the convenience and utility of the general system of absolutely accurate time is noticed in the universal comparison of watches daily at the stroke of noon. This ordinarily causes a movement so general and simultaneous throughout the city as on the one hand to amuse a stranger, and on the other hand to demonstrate how nervously anxious Americans are to secure the highest attainable accuracy in the timekeepers on which they depend for the regulation of private as well as public business. During nearly two years that the system has been in operation it is stated that there has not been any interruption from the failure of electric mechanism, and the utility of the system certainly more than justifies the expense which the city has been to in establishing this now recognized public necessity, which can not hereafter be dispensed with. In fact, the amount of time wasted through the discrepancies of clocks and watches is very considerable, and is directly felt by each individual in the missing of appointments or the needless loss of time in waiting. On very many accounts the country throughout the whole region east of the Rocky Mountains would be benefited by the introduction of some uniform standard of time which should replace the innumerable and often erroneous "local times," and by which not only railroad, telegraph, and stock business might be managed, but which should be adopted also in governmental and in private matters.—*Description of the City Hall, Pittsburgh.*

PROPERTIES OF PRIME NUMBERS.

As the conclusion of an investigation by Goering into the "Theta" functions of Jacobi, and as an application of his results, the author shows that every prime number of the form $6m+1$ is always divisible, although only in one special way, into the sum of a simple and a triple square; and, again, that the product of n prime numbers of the form $6m+1$ can always be considered as the sum of a simple and a triple square.—*Goering, Inaugural Dissertation*, 1874, p. 382.

APPLICATIONS OF PEAUCELLIER CELLS.

Mr. Darwin has given an account of some applications of what are now familiarly known as Peaucellier cells. Among other things he illustrates the fact that it might become possible to construct by means of these a model that shall give an ocular and correct proof of the elliptic motion of the planets about the sun, under the influence of the force varying inversely as the square of the distance in that fixed point. Mr. Sylvester states that he himself had attempted the same problem, but failed.

HAMILTON'S EQUATION OF MOTION.

A decided advance in the principles of theoretical mechanics seems to have been made by Professor Müller, of Zurich, who has developed certain considerations based upon what is known as Sir William Hamilton's general equation of motion. That distinguished mathematician has shown that when a system of material points moves under the influence of forces proceeding from the reciprocal attraction and repulsion of the points of the system, all the integral equations of the motions can be represented by the partial differential quotients of a certain function, called the Primary Function, of their co-ordinates in a manner similar to that in which, according to La Grange, the differential equations of the motions can be represented by the partial differential quotients of a function known as La Grange's function of the forces. The primary function of Sir William Hamilton is a complete solution of the partial differential equations of La Grange's function, as was shown by Jacobi. The integration of this differential equation was developed by Jacobi, since whose time the theory has undergone expansion in two respects, by Zipschitz and Schering, to whose researches Müller adds the following propositions: First, the sum of such changes in the primary function and in the expenditure of force as may be produced by the variations of the initial and final co-ordinates alone, is, in the variation of every motion that presupposes a force function, and neither explicitly nor implicitly contains the time, equal to zero. This proposition he designates as "The principle of Energy." Correlated to the preceding is Müller's second proposition, which he calls "The principle of Action," which may be ennunciated as follows: That change of the action which is conditioned by the variation of the initial and final co-ordinates alone vanishes with the change of every motion that presupposes a force function, and does not contain the time either explicitly or implicitly. Here, as in the previous proposition, if we imagine the whole series of constantly altered motions to be run through with, they will in general be distinguished by different values of potential and kinetic force and energy; in proportion as by the mere alteration of the co-ordinates the potential diminishes, so does the kinetic increase. These propositions, which are represented by Müller in algebraic language, are exemplified by several applications. Applying the first proposition to a simple case, he by it develops the motion of the ordinary pendulum; but his most interesting results relate to the theory of heat. If according to the mechanical theory heat be considered as molecular motion, the application to this hypothesis of Müller's "Principle of Energy" leads immediately to the well-known first law of thermo-dynamics; while, if we apply to these molecular motions the theorem of action, we arrive at a well-known equation already demonstrated by Clausius, and equivalent to the so-called second law of the mechanical theory of heat. We are thus able to derive these important laws from the original principle of Sir William Hamilton's theory of motion, and his general equation thus becomes the connecting band for the two propositions of the mechanical theory of heat.—7 *A*, XLVIII., 274.

ON THE SOLUTION OF NUMERICAL EQUATIONS.

A remarkable theorem relative to the solution of numerical equations whose roots are real is given by La Guerre. He first shows how to draw a certain curve having certain relations to the equation to be solved, and then demonstrates that if from any point whatever of this curve we draw two lines at right angles to each other, the two points where these lines cut the axis correspond to the desired roots.—3 *B*, XXXV., 457.

THE DENSITY OF THE LUMINIFEROUS ETHER.

In a paper on the heat of bodies, Puschel, of Vienna, attempts to explain this property as consisting mainly in a motion of ether identical with the luminiferous ether; and concludes that we may as the lower limit of the density of this substance consider that it must be more than one twenty-sixth billionth of the density of water.—12 *A*, X., 278.

A FINE DOUBLE STAR.

In a recent number of the monthly notices of the Royal Astronomical Society, Mr. Burnham, of Chicago, gives an account of the discovery of the duplicity of *Nu Scorpii*, which is an interesting illustration of the steady progress made in detecting new double stars. As the case now stands, the star in question is quadruple. It was, however, known to Herschel in the last century simply as a double star, whose components appeared single in his own, his son's, and all other large telescopes, up to the year 1847, in which year Jacob, at Madras, found that the fainter or companion star was itself double. In 1873, with his beautiful six-inch telescope by Alvan Clark, and favored by his own remarkably acute vision, Mr. Burnham writes that he had examined the star several times, and was impressed by an apparent elongation of the principal star in a direction nearly north and south. Professor Young, of Dartmouth College, was requested to examine it with his splendid refractor, and reported that he suspected that it was double, but could not be certain. During the summer of 1874, Mr. Burnham with his six-inch telescope, Mr. Newcomb with his great twenty-six-inch refractor at Washington, and Baron Dembowski, at Florence, with a nine-inch telescope, all nearly simultaneously were able to see that the principal star was double, and to measure the relative positions. We have, therefore, in this case a star which to the naked eye appears of the fourth magnitude, resolved by fine telescopes and sharp eyes into four stars, of the fourth, sixth, seventh, and eighth magnitudes respectively. The last-named and most distinguished observer of double stars says that "this is one of the finest multiple stars known." There are others of the same kind, but none presenting the same striking assemblage of brilliant objects within such narrow bounds.—*Burnham on Nu Scorpii.*

HERSCHEL'S CATALOGUE OF DOUBLE STARS.

It is well known to astronomers that Sir John Herschel in his later years engaged himself in collecting, arranging, and revising the previous literary and scientific labors of his life. His general catalogue of all nebulæ discovered up to 1863 was published in the Transactions of the Royal Society of London for the following year. His arrangement of all the double stars observed by his father, Sir William Herschel, was published by the Royal Astronomical Society. The last great work undertaken by him was that of collecting in one catalogue all the trustworthy observations of multiple and double stars which had been recorded up to the date of the undertaking. This catalogue, containing over 10,000 stars, together with a synoptical history of all the known observations of about two fifths of them, was completed at the time of the death of Sir John Herschel. It was bequeathed to the Royal Astronomical Society, at whose expense it has been recently published. This important work will be welcomed heartily by those astronomers and amateurs interested in double-star observations. It unfortunately does not contain any indication of the magnitudes and distances of the double stars of which it treats, but, by giving the positions in right ascension and north polar distance of every known double star, it becomes a valuable aid to those who may be searching for new ones, or to those who wish to add to our present knowledge of these interesting subjects of observation.—*Mem. of Roy. Astr. Soc.*, XL.

ORBIT OF A DOUBLE STAR.

The double star, 70, *Ophiuchi*, which consists of a bright yellow star of the 4½ magnitude, and a rose-colored star of the sixth magnitude, was first observed by Sir William Herschel in 1779, and has since formed a favorite subject of observation for observers in both hemispheres. Some computations based on these observations have lately been made by Flammarion, in order to determine the apparent orbit and, if possible, the true orbit of this sidereal system. Flammarion's results are practically identical with those of Klinkerfues, as deduced a number of years ago. Flammarion, assuming the parallax as determined by Krüger, concludes the distance of these stars from the earth to be 1,400,000 times that of the sun, and the actual distance of the two stars from each other to be somewhat less than the distance of Neptune from the sun. The relative movement of the stars is, according to Klein, 1.65 that of Neptune and the sun. The two stars have, however, a common movement through space, which is three and a half times as great as their orbital velocities about each other.—19 *C*, VIII., 46.

THE ORBIT OF THE DOUBLE STAR "MU BOOTIS."

Among the theses published by the University of Kasan, in Russia, is an investigation into the orbit of the double star *Mu Bootis*, by Venogradski. Observations of this star have been made since 1782, when it was first observed by the elder Herschel; and its orbit has been investigated once previously by Wilson, but the computations of Venogradski take precedence, inasmuch as he has had access to very accurate and long-continued observations of Otto Struve and Dembowski. During the past ninety years the smaller star has described nearly one half of its orbit about the larger one; and the mutual distance has diminished from one and a half seconds to less than half a second. According to the present computation, the periodic time of these stars is about one hundred and eighty-two years; the inclination of the orbit being 47.5 degrees, and its eccentricity 0.5. The probable errors of the measurements of the distance of the stars is scarcely one tenth of a second. According to the ephemeris published at the conclusion of the work of Venogradski, the relative movement of these stars is at present at its maximum.—*Journal of the Imperial University at Kasan*, XLI., 311.

SPECTRA OF THE FAINT STARS.

Vogel states that for some time past he has been almost exclusively occupied with the spectroscopic investigation of faint stars. Among these are some that are distinguished by having spectra which are sharply defined at the violet side, but on the red side are broken up into gradually diminishing bands. These are generally red stars. By a somewhat careful study of these spectra it seems to him undoubted that their discontinuity is only apparent, being brought about by dark bands of absorption, which, as we must assume, are the consequence of the absorption of the rays of light by the atmospheres surrounding these stars. The only rational classification of star spectra is, according to him, into the following three classes: 1. Stars whose temperature is such that the metallic vapors contained in their atmospheres can exert only a very slight absorptive effect. 2. Stars whose atmospheres, as in the case of our sun, are distinguished by powerful absorption due to vaporized metals. 3. Stars whose temperature is so lowered that the materials which compose their atmospheres can combine together. In the latter class Vogel embraces both the third and fourth types of spectra established by Secchi.—*Astronom. Nachrichten*, LXXXIV., 115.

ON THE SCINTILLATION OF THE STARS.

Montigny has lately presented to the Royal Academy of Brussels a continuation of his researches on the scintillation of the stars. In this work he has studied not only the number of bands in the spectra of the stars, but also their growth, and especially the obscurity of the lines and zones which characterize the bands. Making use of the observations of Secchi, he thinks he has been able to show with considerable exactness the connection between the frequency of the scintillations and the characters of the spectra, having regard especially to the four types that have been proposed by Secchi. The comparison of his own and Secchi's observations leads him to the conclusion that the stars which have been chosen as showing spectra typical of the first and second classes are also those which have the most frequent scintillations. The typical stars of the fourth class of spectra are those whose scintillation is the most feeble. Those stars of the first class which scintillate less than the typical stars are in general distinguished by having less numerous spectral lines. These conclusions he subsequently finds confirmed by the observations of Huggins and Miller. His essay concludes by a calculation of the actual differences between the lengths of the routes through the air of the components of the light of any star, and this leads him to a formula which is applicable to the calculation of the relative frequency of the scintillations of various stars at different zenith distances.—*Bull. Roy. Acad. of Belgium*, 1874, 300.

THE STRUCTURE OF SOLAR SPOTS.

The study of the solar spots has very wisely been made a matter of especial attention at the observatory of Allegheny City, Pennsylvania, and Professor Langley, the director of that institution, has the credit of having published the finest photographs and engravings that have ever yet illustrated the subject. From the very cautious wording of a recent communication from him, we gather that among the typical characteristics of the solar phenomena he has observed the following new points: 1. The filaments both of the penumbra and of the umbra are all disposed in curves, which partake of the spiral type, bearing witness to the existence of a force directed toward the centre of the spot; but it does not appear that a uniform direction of rotation prevails, since some of the filaments turn to the one, and some to the other direction, while some have a distinct double curvature. 2. The filaments grow progressively brighter toward their extremities, no matter whether they are long enough to reach from the photosphere to the edge of the penumbra, or whether they are shorter than this. 3. He finds the blackest part of the spot to be intrinsically very bright, and its reddish-brown masses are by his telescope resolved into filaments analogous to the penumbral ones, being disposed in curves, and having brighter extremities, as if their ends curled upward. Langley sees no evidence of crystalline forms, but judges rather that we seem to look down through increasing depths of transparent whirling vapor, visible objects growing fainter till lost to sight at an unknown depth below the surface. The striking forms seen in the solar atmosphere are, he thinks, most nearly typified by certain rare types of cirrus clouds in our own atmosphere. In very many spots Mr. Langley recognizes the movement of one stratum of solar atmosphere over another.—4 *D*, IX., 192.

AGREEMENT OF SECCHI'S VIEWS WITH PROFESSOR LANGLEY'S.

The very beautiful solar drawings published in the American and Italian journals by Professor Langley, of Allegheny City, together with the announcement of the conclusions reached by him from his study of the solar spots, has called forth some remarks by Secchi, of Rome, in which the latter seems to claim a certain amount of priority in respect to the ideas of Langley, and to maintain that they agree with each other to a very considerable extent. This, however, can only be true in case Secchi relinquishes certain of his long-held theories, and it is, therefore, important to put on record his conversion to the views of Professor Langley.

WHITE LINES IN THE SOLAR SPECTRUM.

Mr. Hennessy writes, from Massorie, to Professor Stokes, that he has observed in the solar spectrum certain white lines for whose existence he is unable to account. He can not think that these are due either to the instrument or to the latitude of the station. The white lines in question can not be described as absolutely white, yet they closely resemble threads of white frosted silk held in the sunlight. They are best seen about noon.—7 *A*, XLVIII., 305.

PHOTOGRAPHS OF STELLAR SPECTRA.

Mr. Lockyer, in a recent lecture on spectrum photography, gives great prominence to the admirable labors of Messrs. Rutherford and Draper in New York City, stating that the latter gentleman has not only taken the most perfect photograph of the solar spectrum yet obtained, but has succeeded in getting an admirable photograph of the spectrum of a star. It will thus become possible to study any changes that may take place in the constitution of the stars or the sun by the comparison of these photographs with such others as may be taken at some future time.—12 *A*, X., 255.

ZÖLLNER'S THEORY OF THE SOLAR SPOTS.

The theory of Zöllner as to the constitution of the sun and its spots has been thus described by him: The sun is a glowing liquid body, surrounded by a glowing atmosphere; in the latter, at a certain distance above the fluid surface, there floats a covering, constantly renewing itself, of shining clouds, like our own cumuli. At those places where the cloud canopy is thinned, or dissipated, there arise on the glowing surface, by reason of powerful radiation, the slag-like products of cooling. These, therefore, lie deeper than the general level of the shining clouds, and form the nuclei of the sun spots. Above these cooled regions there are formed descending currents of air, which give rise to a circulation of the atmosphere around the edges of the islands of slag, to which circulation the penumbra owes its origin. The cloud-like results of condensation, which are formed within the region of this circulation, have their shape and temperature determined by the nature of the circulation itself, and must, therefore, in consequence of their lower temperatures, appear less brilliant than the other portions of the cloud canopy of the solar surface, and seem depressed like a funnel, by reason of their descending motion above the spot. The exterior edge of the penumbra is at the level of the shining canopy.—*Poggendorff Annalen*, CL., 300.

ANCIENT OBSERVATIONS OF SOLAR SPOTS.

In the 29th volume of the meteorological observations at Lyons, France, an account is given of some early observations of the solar spots made by Father Beraud. In 1741, on the 8th of April, he observed eight pretty large spots on the sun. From the 16th to the 30th a remarkable spot fixed his attention. It was composed of an obscure portion of irregular form, situated between two black points, the whole enveloped by a brown cloud composed of small black points. The whole had a round form, whose apparent diameter was 55 minutes of arc, or three times the diameter that the earth would appear to have if placed at the same distance.—13 *B*, III., 134.

THE SOLAR ATMOSPHERE.

Zöllner has published in detail his defense of his views as to the nature of the solar spots, basing his reasoning principally upon laws announced by Kirchoff in his investigations of the solar spectrum. He first shows that if the lowest strata of the solar atmosphere radiate as intensely as they absorb, clouds in that atmosphere will be scarcely distinguishable, so far as any difference of brightness is concerned between them and the neighboring atmosphere; and, secondly, he states that it is not sufficient to assume the existence of clouds, but that some reasonable cause must be assigned for their continued existence for weeks and months. In his exhaustive analysis he shows that local cooling can not be explained by conduction of heat, and that, therefore, up-rushing or down-rushing currents of cooling gas can not be produced by this cause. The influence of radiation being thus the only resource left, he draws analogy between the solar spots and the formation of dew in the earth, and seeking those circumstances under which the radiation from the surface of a body is localized for the longest time, he finds that such radiation proceeds most freely when the body is a solid; hence he concludes the solar spots to be of a solid nature.—*Poggendorff Annalen*, CL., 298.

THE DIMENSIONS OF THE SUN.

Some of the results of the studies of Secchi having been severely criticised by Anwers, he has recently edited a work by Father Rosa, which will, in part, serve as an answer to these criticisms. The investigations of Rosa and Secchi are based upon observations made during the past hundred years at Greenwich, Dorpat, and Königsberg, and Secchi believes that they show that the body of the sun must be considered as consisting of two quite independent masses, viz., a solid nucleus, surrounded by an atmosphere of gas. Instead of the solid nucleus, we may also understand the central portion to be a mass of gas in such a state of condensation that it is to a great extent independent of its lighter envelope. The photosphere, according to these authors, is subject to periodical variations, which are not directly due to the force of gravitation. The force which specially deforms the photosphere is intimately connected with that which affects the secular movement of the centre of gravity of the sun, as has been shown by Le Verrier. The secular changes of the photosphere and of terrestrial magnetism are subject to a simultaneous oscillation of sixty-six and two-third years, similar to that equal period to which the perigeum of the apparent solar orbit is subject.—19 *C*, VIII., 33.

ON SOLAR RADIATION.

One of the most comprehensive investigations into the subject of solar radiation is that recently published by the Rev. F. W. Stowe, based on five years' observations at twenty-five stations, with the black bulb maximum thermometer in vacuo, freely exposed to the sun and air at the height of at least four feet. By the amount of solar radiation, he understands the excess of the reading of the solar thermometer above that of the ordinary maximum thermometer placed in a double-louver screen. Incidentally he mentions that the solar thermometer seldom reads above 140° Fahr. in England, and that 134° is the highest temperature on his records. The radiation attains its maximum in May. This is to be attributed to the prevalence of northerly winds, and consequent dryness of the atmosphere. December is the month of least radiation. In this statement we take account only of the maximum amounts of radiation during clear days in those months. The western stations in England show more radiation than the easterly ones. The neighborhood of the sea appears to somewhat diminish solar radiation during the summer, which he attributes to the fact that the air from the sea is, for the most part, heavily loaded with vapor during the summer season. The excess of radiation at western stations, he is inclined to attribute to the greater purity and coolness of the air, and its freedom from haze. As regards secular change, he found the radiation decidedly in defect in the early summer of 1870, but in excess in 1872, a result which may have resulted from the presence of a colder stratum of air in unsettled weather, and in part, also, from increased reflection from the clouds. In speaking of the defects of the solar thermometer as a means of measuring the intensity of solar radiation, he states that when a perfect actinometer is proposed for general use by meteorologists, the blackened bulb in vacuo must give place to it; but in the mean time it is the best instrument that can be used for ordinary observations. Among the defects experienced in the use of this thermometer is its liability to be influenced by reflection from neighboring bodies. The reflection from the illuminated side of a cloud is very great. In this respect, Mr. P. Harrison stated that he was able to confirm Mr. Stowe's conclusions.—*Quar. Jour. Meteor. Society of London*, II., 205.

SOLAR RADIATION.

At the physical observatory at Montsouris, near Paris, regular observations are made of the radiation of the sun by means of a simple actinometer. If the atmosphere were perfectly diathermanous and the days of uniform length, the average power of the sun, allowing for its varying distance, would be the same throughout the year, and may be placed at 100°. But through the influence of the variable amount of moisture and cloud, and the variable lengths of the days, the actinometric power varies; and, according to the observations at Montsouris, while it is theoretically in December about 31°, and in June 77°, of our arbitrary scale, it was actually observed to be in December 29°, and in June 68°, showing that the earth received during those months in 1873 and 1874 slightly less heat than the average.—19 *C*, VIII., 114.

STUDIES ON SOLAR RADIATION.

M. Desains has attempted to resolve an important meteorological problem: viz., to determine the total weight of the vapor of water contained in the atmosphere in a given region. He has made preliminary observations at Lucerne and Rigi Culm, and from these he deduces the absorption of solar heat due to a thickness of one centimeter of water. He states that, by a long-continued series of observations of a similar kind, he hopes to be able to compile hygrometric tables which will give, for any observed intensity of solar radiation, at two stations, the corresponding total weight of the vapor of water contained in the entire atmosphere. At Paris he finds, for instance, that for equal thicknesses of air its diathermancy varies from $\frac{6}{10}$ to $\frac{8}{10}$, which variations are greater than those which would have been obtained by interposing or removing a screen of water one centimeter thick.—2 *B*, XXXIV., 230.

MEASURING THE CHEMICAL ACTION OF SUNLIGHT.

Dr. Phipson says that many years ago he made some experiments on the measurement of the chemical action of the solar rays, and described an accurate method of effecting it. Having discovered that a colorless solution of molybdate of ammonia in sulphuric acid became greenish blue when exposed to the sun, and colorless again during the night, and that the amount of chemical action exerted to produce this tint may be accurately determined by using a dilute solution of permanganate of potash, he suggests that, in order to possess a perfectly accurate process by means of which to determine the chemical intensity of solar light, we have only to expose always the same quantity of the substance to the light for the same period of time, and then determine the tint produced therein by the action of the sun's rays.—18 *A*, XX., 124.

THE TEMPERATURE OF THE SUN.

The two methods of making the measurements of solar heat may be described as the dynamic method and the static method. The former is that on which the pyrheliometer of Pouillet is based; in which method a thermometer is exposed alternately in the shade and in the sun. In the static method the thermometer remains permanently subject to solar radiation; until the temperature indicated by it becomes stationary, at which time the temperature of the thermometer and that of the inclosure are noted. The principle on which the static method is founded has been investigated by Vicaire, whose results have lately been further modified and improved upon by Violle, who shows how to take account of the diameter of the bulb as well as its own radiation; he has made investigations into the temperature of the sun, the radiation of the sky bordering the sun, and the general absorption of the solar atmosphere.—7 *A*, XLVIII., 158.

VARIABILITY OF SOLAR TEMPERATURES.

Mr. Blandford, of Calcutta, gives the results of his studies into the variability of solar temperatures as indicated by the maximum black bulb in vacuo solar thermometer. Mr. Blandford's investigations are based upon observations made from 1868 to 1874 at stations in India, and his results seem very striking, if not absolutely conclusive, as to the direct variation of the solar heat with the number of the spots and prominences. The absolute maximum temperature of the sun seems, according to his diagram, to have been reached in February, 1871. Unfortunately the highest sun temperatures recorded by his thermometers occurred not on days that were cloudless, with a very dry atmosphere, but on those in which there was a considerable proportion of cloud and frequent rains. The effect of the heat reflected from the edges of the cumulus clouds upon his thermometers seems not to have been duly considered by him.

THE TEMPERATURE OF THE SUN.

An improved method of investigation to determine the temperature of the sun has been put in execution by Violle, who describes his apparatus as consisting essentially of two concentric and spherical envelopes of brass. In the centre of the interior one is the bulb of the thermometer, while between the two envelopes a continuous current of water circulates. The exterior surface is highly polished, while the interior surface of the interior sphere is covered with lampblack. The experiment is conducted by first determining the temperature shown by the interior thermometer without exposure to the sun and then the temperature as shown during the exposure to the sun and after it has become stationary under the influence of the solar rays. The conclusions that can be drawn from this apparatus depend upon the employment in succession of different thermometers and different apertures of the diaphragm which allows the solar rays to fall upon the thermometer. Violle has made a very careful investigation into all the influences which can affect the indications of the thermometer, and from some preliminary experiments finds that the temperature of the sun, after making the correction for the absorption of the terrestrial atmosphere, is 1354° Centigrade.—7 *A*, XLVIII., 236.

THE TEMPERATURE OF THE SUN.

We have already mentioned the interesting researches of Violle upon the measurements of the temperatures of the heavenly bodies, and have now to record a preliminary but very approximate result arrived at by him for the temperature of the sun, the correction being made for the absorptive influence of the earth's atmosphere. He defines the true temperature of the sun as that which must be possessed by a body of the same apparent diameter as the sun in order that, endued with an emissive power equal to the mean emissive power of the sun, it may emit in the same time the same quantity of heat as the sun. The observations made by his instrument, described in the previous note, by a method which he characterizes as the dynamic method, have enabled him to determine the emissive power for heat of steel after fusion, just as it issues from the Martin-Siemens furnace, and he finds it corresponds to a temperature of 1500° Centigrade. If now we assume that the mean emissive power of the sun is sensibly equal to that of steel in fusion, we arrive at the value of 2000° Centigrade for the true temperature of the sun's surface.—7 *A*, XLVIII., 396.

REFLECTING POWER OF THE PLANET MERCURY.

Zöllner has extended to the planet Mercury a series of photometric observations similar to those made by him some years ago upon the moon. The observations made, upon two especially favorable evenings, gave him, for the relative brightness of Jupiter and Mercury, the ratio 2.7 in one case, and 3.2 in the other. A comparison of the peculiarities of the results for Mercury and the moon leads him to the conclusion that Mercury is a planet whose superficial condition very nearly agrees with that of the moon; that also, like the moon, it probably possesses no atmosphere. The reflecting power, or albedo, of Mercury is the least of all the planets, and even less than that of the moon. Zöllner also makes a very ingenious attempt to determine the albedo of the earth, and the law of the variable intensity of the light that will be exhibited by it, in its various phases, as seen from a distant planet. Concerning his attempt to determine this albedo through observations of the dark limb of the moon, he states that, although the results can scarcely be accepted as having much accuracy, they nevertheless show the practicability of the method.—19 *C*, 1874, 150.

THE ATMOSPHERE OF VENUS.

Lohse has investigated what would be the effect and appearance of a spherical gaseous mass passing over the solar disk as seen from the earth, and has sought to apply his result to the possible effect of the atmosphere of Venus on the phenomena of the Venus transit. In conclusion, he states, with reference to the so-called black-drop phenomenon, that if the atmosphere of Venus has a density so great that it unites the solar rays in one point lying between Venus and the earth, it must then have the same effect as an opaque body—that is to say, the solar limb will by this atmosphere be broken or indented before the body of Venus itself touches it; and, conversely, the solar limb will not regain its integrity, at the close of the inner contact, until the atmospheric layer is entirely within the solar disk. It is possible that, at the inner contact, this effect of the atmosphere of Venus contributed considerably to the appearance of the so-called black drop.—19 *C*, 1874, 170.

THE VISIBILITY OF THE PLANET VENUS.

Professor Safarik, of Prague, endeavors to explain the intense brightness of Venus, and particularly the dazzling splendor of her bright limb, without assuming specular reflection on the surface of the planet. He remarks that the intensity of the phosphorescence of the sea in our tropical waters is not fully appreciated by the near observer, who therefore has only a faint idea of the intensity which this phenomenon can acquire under highly favorable circumstances, and the author thinks it not unreasonable to suppose that such a phosphorescence can be seen even at the distance of Venus. If so, it explains the fact that the edge of the dark limb of Venus is seen brighter than its central part; for it is demonstrable by calculation and confirmed by observations that a rough surface reflecting diffused light appears the brighter the more obliquely it is regarded.—*Report Brit. Assoc.*, 1873, 408.

THE TIDAL RETARDATION OF THE EARTH'S ROTATION.

In some remarks on the various causes that operate to retard or accelerate the earth's daily rotation, Mr. Mallet remarks that if we take into account all the operations at work upon the earth's surface, such as the flowing of rivers down hill into the ocean, the carriage of great masses of earth, as mud, from the upper sections of the earth to the bottom of the ocean, the fall of raindrops, the flow of rivers from low to high latitudes, and all other similar seemingly insignificant causes, we shall find no reason to suppose that the retardation of our globe by tidal friction, whatever may be its actual amount, can go on unchecked until the earth is brought to a stand.—7 *A*, XLVII., 40.

THE MASS OF JUPITER.

Powalky has attempted a new determination of the mass of the planet Jupiter, by examining its perturbing influence on the movements of the asteroid Virginia (No. 50). The result to which he is led indicates that the mass of Jupiter should be increased by about one two-hundred and seventy-second part of the present adopted value; but although this correction enables him more nearly to satisfy the observations that have been made upon Virginia, he is yet inclined to attribute to it only a slight value, and hopes to attain better results by a repetition of his work in future years. —*Astron. Nach.*, LXXXIV., 71.

THE SATELLITES OF URANUS.

An interesting study has lately been made by Professor Holden, of the Washington Observatory, on the observations of Sir William Herschel upon the satellites of Uranus. It is well known that the latter astronomer announced sixty years ago that Uranus was accompanied by six satellites; but of the existence of four of these there has always been considerable doubt, since no one was ever able to confirm the observations of Herschel. In 1847 Lassell discovered two interior satellites, which were, however, different from those which Herschel suspected; and since that day the four problematical satellites of Herschel have been generally discarded by astronomers. Professor Holden now brings testimony to the high excellence of Herschel's observations, as, by computing backward, he has shown that probably this distinguished astronomer actually observed the two interior satellites of Lassell (named by him Ariel and Umbriel); but that he was unfortunately prevented from identifying them as satellites because his telescope could not show them on two successive nights. The extreme difficulty of observing these objects makes us wonder at the marvelous skill and patience manifested by the elder Herschel in this laborious research, which was carried on by him from 1787 to 1810.—*Bull. Phil. Soc. Washington, Appendix* IV.

ORIGIN OF AEROLITES.

During the last two or three years the discovery of energetic forces of eruption on the sun has demonstrated the occasional occurrence of convulsions so violent that they may suffice to project molten and gaseous matters to distances beyond the sphere of the sun's attraction. The existence of such forces and the evidence which the microscope affords that aerolites have had their origin among mineral masses in a state of fusion, if not of vapor, combine to support the theory, formerly entertained by other writers and recently announced very definitely by Mr. Proctor in England and Professor Kirkwood in America, of the astro-meteorological hypothesis of the origin of meteors and meteorites.—*Report Brit. Assoc.*, 1873, 400.

THE GREAT COMET OF 1684.

The investigation of the great comet of 1684 forms the subject of the inaugural dissertation of Professor Neugebauer of the University of Breslau. This comet belongs to those which, on account of the close approximation of their orbits to the earth's orbit, have attracted the attention of Professor Schiaparelli as worthy of scrutiny in connection with shooting-stars. The only accurate observations of the comet of

1684 that have come down to us were made during two weeks at Rome by Bianchini; and in order to derive from these the best possible results, Neugebauer has reduced them all anew, by using the best materials available, he having access to original letters and drawings still in existence. The observations made by Bianchini were of the simplest kind; for instance, he would hold a stretched thread in such a position that, while it covered some one of the known fixed stars, it nearly covered the comet itself, whose position, relatively to the ends of the thread, was then estimated by the eye. Other and more exact observations were made with the help of rude instruments. The relative positions of the comet, as deduced by great labor, in general seem to be trustworthy to within a few minutes of arc, and Neugebauer's elements of its orbit are not greatly different from those given by Halley. It follows, as the most interesting result of the investigation, that on the 18th of June, 1684, the distance of the comet from the earth was only the hundredth part of the distance of the earth from the sun, being, in fact, only the thirtieth part of the distance of the earth from Coggia's comet on the 21st of July, 1874, when it was nearest the earth. It seems, therefore, that the orbit of the comet of 1684 approaches more nearly to the orbit of the earth than almost any other known comet, and that under favorable circumstances we shall be justified in expecting some meteoric display yearly about the 18th of June, at which time the earth annually comes into the plane of this comet's orbit.—*Inaugural Dissertation*, *Breslau*, 1873.

THE PHENOMENA OF COMETS.

As the result of a suggestive paper by Faye on the forms of comets, he states that he has been led to conclude with perfect certainty that cometary phenomena reveal to us in the heavens the existence of a second force totally different from attraction, and capable of playing an important part, and producing before our eyes gigantic phenomena; that, with great probability, this force is nothing less than the repulsion due to heat. In order to demonstrate experimentally the existence of such a repulsion (which is mathematically deducible from the dynamic theory of gases), he advises the following arrangement: A jar of very rarefied air is illuminated by means of the spark of an induction apparatus; the glass bell-jar in which the vacuum is to be made is traversed by the two wire conductors of the apparatus, the one vertical and the other horizontal, and the induction spark itself appears in the form of feebly luminous rays, whose colored stratifications surround the horizontal conductor with a luminous sheath of a well-marked blue color. The horizontal wire having been made of a thin plate of platinum, an independent electric current is passed through it, so as to render it red-hot, and immediately the blue-colored sheath of rarefied air is repelled from the red-hot platinum plate. After having made all possible variations of this experiment, he concludes that it demonstrates a repulsion between the heated platinum and air.—12 *A*, X., 289.

THE CONSTITUTION OF COMETS.

Mr. Lockyer briefly reviews the state of our knowledge as to the spectroscopic observations of comets. In general, observers seem to agree that these bodies consist, in part at least, of not very dense incandescent vapor, while in some cases very dense or possibly very complex vapors, or even glowing solid substances, seem to have been present. Huggins first suggested the idea that the rarer cometary vapors might be composed of nitrogen, but subsequently suggested the theory that a comet is composed of carbon, and that a temperature prevails high enough to volatilize a portion of this substance, giving rise to the three bands coinciding with those of olefiant gas. Mr. Vogel has, however, shown that this is a very questionable theory, and that we are only justified in concluding that a portion of the light emitted by the comet is its own light, and very probably comes from glowing gas. Mr. Lockyer, moreover, found the nucleus of Coggia's comet deficient in blue rays, whence its temperature must have been low, which conclusion is further justified by the fact that cometary light gives channeled space spectra, which latter are peculiar to low temperatures.—12 *A*, X., 180.

THE FORMATION OF THE TAILS OF COMETS.

The distinguished Italian astronomer, Schiaparelli, has communicated to the journal of the Italian Spectroscopic Society some studies upon the nature of the repulsive force which contributes to the formation of the tails of comets. The actual existence of this force is established by the accurate observations that have been made. He examines successively the various theories that have been put forth—the electrical theory as proposed by Zöllner, the molecular theory of Zenker, and the theory of Faye that repulsion is exerted by all incandescent surfaces, and that thereby the gaseous matters attending the comets are repelled from the surface of the solid nucleus. The latter does not seem to Schiaparelli to afford any material explanation of the phenomena. The electric theory was first suggested by Olbers, but has been in general terms objected to by Herschel, Lamont, etc. Zöllner's views have been elaborated more minutely, and he has endeavored to show that the free electricity existing upon the surface of the earth is sufficient to produce an effect similar to that found in comets; but his conclusions are in too many respects at variance with actual observations to allow the author to consider them as affording a reasonable explanation as to the nature of comets. Zenker's views are rejected by him for the reason that the evaporation of fluids from the surface of the nucleus should give rise to several phenomena not seen in comets, while, on the other hand, it does not explain the multiple tails which have frequently been observed. In conclusion, Schiaparelli thinks that we are forced to believe that the repulsive force acting upon comets is a force exterior to the comet itself, and since this force evidently operates in the direction of the radius drawn from the comet to the sun, therefore we must regard it as having for its origin the sun or some medium surrounding the sun, and he adds that this is about all we at present know upon the subject.—3 *B*, XXXV., 263.

WINNECKE'S COMET.

The comet known as Winnecke's comet is a very faint telescopic comet, whose recent appearance was observable by only a few of the largest telescopes in the world. It was first observed in 1819, but attracted no notice until in 1858 it was again observed by Winnecke. From the observations made at that time, Winnecke showed that it accomplished its revolution in its orbit in about 2400 days, and that it was identical with the comet of 1819, having made seven revolutions about the sun since that time without having been observed. Its short period of revolution gives it an additional interest; its movement seems to have experienced no disturbance in the course of the two revolutions that it has made during the past fifteen years.—13 *B*, III., 174.

ON THE REPULSIVE FORCES OF COMETS.

Schiaparelli has recently published his views upon the cause of the peculiar phenomena exhibited by comets, views which he has entertained and in part published since 1862, during which time, on the other hand, he has taken so prominent a part in the development of our knowledge of shooting-stars. According to Schiaparelli, there actually exists a repulsive force, not only between the sun and the tail, but also between the particles composing the nucleus and the tail of a comet; and the phenomena exhibited by these bodies can not be explained without assuming these repulsive forces. In fact, if we consider, first, the formation of the tail itself, we shall find that the solar gravitation and the movement of the comet do not suffice to explain it, as has been abundantly testified to by all who have minutely examined the observations that have been made. Again, too, if we consider the tail itself, and its path in space, we shall find, as has been shown by Bessel in reference to Halley's comet, and by Pape and Bond in reference to Donati's comet, the existence of a repulsive force repelling the comet from the sun results with as much certainty as the movements of the earth prove the existence of an attracting force toward the sun. The third comet of 1862, on the other hand, whose tail was not projected in a direction opposite to the sun, but continually approached this direction as the comet moved away from the sun, shows that the repulsive force acts upon the particles of the tail as well as upon the nucleus of the comet; that, in fact, the tail was first sensibly brought under the influence of the sun after it had been projected from the nucleus of the comet by a force residing therein. Under a minute examination, the head of a comet sometimes shows beams of light projected from the nucleus, but subsequently turning back and forming portions of the tail, so that here, also, the existence of the repulsive force is apparent. Finally, the increase in the breadth of the tail as it separates from the nucleus shows that the repulsive force is exerted, not only between the sun and the tail, but also between the separate atoms of which the tail is formed. Since, thus, repulsion is proved, and even apparent as we may say, we must attach some value to the determinations that have been made by Bessel, Pape, and Bond, who were obliged to make certain hypotheses as to the development of the tail, while, on the other hand, the third comet of 1862, like many others, seems to have developed its tail in such a manner that we have at present no safe foundation for computing the amount of the repulsive force existing therein.—19 *C*, VIII., 109.

PECULIAR AURORAL PHENOMENA.

The nature of the auroral light is the subject of a communication by Lemström, who concludes that the white flaming appearances occasionally seen on the summits of mountains in Spitzbergen and in Lapland are of the same nature as the northern lights. Similar appearances have also been seen in other parts of the world. Electrical currents that develop themselves in the earth when the auroras are present are not induction phenomena caused by the atmospheric auroral currents, at least not in northern regions.—19 *C*, VII., 383.

THE SPECTRUM OF THE AURORA BOREALIS.

The late Professor Angström, who at no time accepted the theory that the spectra of gases varied with the pressure and temperature and chemical process, advanced the opinion that the spectrum of the aurora borealis is composed of two different superposed spectra, the one consisting of extremely feeble bands of light, belonging to the spectrum of the negative pole, the other consisting of a single strong yellow line, which is characteristic of the aurora, and which, Angström believed, owes its origin to fluorescence or phosphorescence. —12 *A*, X., 211.

THE GEOGRAPHICAL DISTRIBUTION OF AURORAS.

In a recent paper in Petermann's geographical notices, Professor Fritz, of Berne, gives the results of his researches into the geographical distribution of auroras. Having as far as possible eliminated the sources of error arising from the fact that few observers preserve complete records of the aurora, and that few records which continue over a number of years have a uniform degree of completeness at all times; having also eliminated the periodic changes, both the diurnal and the annual, and after making allowance for the relative cloudiness of the different stations, Fritz presents a map compiled from the records for upward of two hundred places in Europe, Asia, and America. He discusses with great care the probable value of the observations, and then draws lines of equal frequency of auroral display, or isochasms.

The zone of maximum frequency is a narrow belt passing just north of the North Cape and the Siberian coast, through the northern part of Spitzbergen, and near Point Barrow, Great Bear Lake and Nain on the coast of Labrador. According as we go from this zone northward or southward, we come to regions of gradually diminishing frequency and diminishing intensity of auroral display; and it is important to observe that, while south of this zone of maximum frequency the auroral arches are generally seen north of the observer, they appear to stations on the north of it to be south of the observer's zenith, while to those upon the zone they appear indifferently to the north or south. The whole system of belts deduced by Dr. Fritz has very great similarity to, and almost coincides with, those given by Muncke in 1820, and by Loomis in 1856. The curves of equal frequency generally cut the magnetic meridians at right angles, and apparently follow the borders of the continents and the limits of perpetual ice; upon which fact Professor Fritz seems inclined to dwell with special attention, and to conclude therefrom that the atmospheric electricity produced by the friction of winds blowing over ice-fields has something to do with the exhibition of the aurora. It has been suggested, in carrying out the same idea, that it may not be unlikely that the aurora varies with the increase and decrease of the ice, whence, by analogy, it may be concluded that the neighborhood of the Alps may influence the frequent displays of aurora seen in Northern Italy.—12 *A*, XI., 14.

GROUND CURRENTS AND THE AURORA.

In some remarks on the auroras of February 4, 1871, and 1872, Mr. Tarry states that it appears from the observations made at the telegraph bureau at Brest that magnetic and telegraphic disturbances preceded, accompanied, and followed the apparition, which was a visible but, in fact, only secondary part of the phenomena. The aurora borealis is in reality a magnetic storm, as defined by Humboldt, and it is only by the study of the changes experienced by terrestrial magnetism during these apparitions that we shall come upon the true cause of the phenomenon; moreover, inasmuch as the magnetic disturbances are always recognizable long before the appearance of the aurora, we can easily predict the latter. The disturbances of terrestrial magnetism have probably a cosmical cause, and it is impossible to study them properly except throughout the whole world simultaneously.—*Nouvelles Meteorologiques*, p. 36.

THE CELESTIAL INDICATOR

Is the name of a pretty piece of apparatus, patented, we believe, by Mauperin, of Paris. It is designed to enable one to determine instantly the name of any star or constellation by simply pointing in its direction with the indicator of the instrument. The apparatus consists essentially of a tripod stand supporting a circular table, which may be inclined at any angle to the horizon. On this table is engraved a map of the stars, and its circumference is divided into degrees and the divisions of the year. From its centre there stands up a column which revolves about its axis, and supports at its top a pointer. This pointer is movable about its centre in a plane perpendicular to the table, while in a horizontal direction it carries a second pointer, fixed at the base of the column, and therefore in close contact with the map of the stars. It of course follows that when the upper pointer is directed toward any stars, and the star map is properly oriented for the day and the hour, the lower pointer will then cover the star in question, and its name may be read on the chart. A lantern attached to the table illuminates the chart sufficiently, so that the whole stand may be carried out of doors and used there with convenience. The indicator may also be used for the inverse process; that is, for making charts, and, perhaps with advantage, may be employed by observers of shooting-stars and auroras. It might also, at least in principle, be extremely convenient to those who are engaged in drawing and studying the clouds.—*Bulletin Hebdomadaire*, XVI., 25.

ON THE ERRORS OF MICROMETRIC MEASUREMENTS.

In the course of an excellent series of measurements of the relative positions of the stars in the cluster of Sobieski's Shield, Professor Helmert has made a determination of the so-called personal errors in micrometric measurement of position angles. As Otto Struve and Dembowski are the only astronomers who have as yet thoroughly investigated this important source of error, the results of Helmert's observations are especially valuable. The apparatus used by the latter can easily be applied to any telescope, and will, it is hoped, be frequently applied by others. Helmert concludes that there was possibly in his case a gradual change in his method of observation, and that when this is eliminated there still remains a periodical error in his measurements of angles, which, although much smaller than that of Otto Struve, is quite similar to it in its general features.—*Publications of the Hamburg Observatory*, No. 1, p. 19.

ASTRONOMICAL WORK WITH THE GREAT MELBOURNE TELESCOPE.

From the proceedings of the Royal Society of Victoria we learn that during the past five years Mr. Ellery, of the Melbourne Observatory, has examined the positions of 38,000 stars. The great reflecting telescope, of four feet aperture and forty feet focal length, has been employed in examining the star Eta Argus and its surrounding nebula. The spectrum of this star is found to be crossed by bright lines, which seem to indicate that hydrogen, nitrogen, sodium, and magnesium are present—no dark lines having been seen with certainty, though they were suspected. Considerable changes have, however, occurred in the spectrum, if we may judge from a comparison of the records of 1869 and 1874, since in the latter year no bright lines were to be detected, while a distinct nebulosity surrounded the star, which had formerly appeared projected on the black background. The nebula surrounding this star is evidently subject to great changes. In the spectrum of Jupiter absorption lines constantly appear. An examination of the small stars near

Sirius shows, besides Alvan Clark's companion and that of Lassell, eight others within a distance of one minute of arc. —12 *A*, XI., 90.

THE GERMAN NAUTICAL OBSERVATORY.

It may be known to some of our readers that since 1868 there has existed in Hamburg a private institution representing the combined nautical and meteorological interest of that city. The control and support of this institution has lately been assumed by the German Government under the following regulations, among others: By the name "Deutsche Seewarte" an institution is established whose problem shall be to further the knowledge of the ocean, so far as this is of interest to navigation, as also that of the phenomena of the weather on the German coasts, and to utilize this knowledge for the safety and expedition of navigation. The Seewarte is located at Hamburg, and has under it nine observing stations and forty-five signal stations along the German coast. The annual appropriation for the entire establishment and its dependencies is 75,000 marks.—7 *C*, XI., 130.

THE FIXED HORIZONTAL TELESCOPE OF LAUSSEDAT.

The Siderostat is the name given by Foucault to the perfected form of the apparatus originally used by Laussedat for photographing the sun. It consists essentially of a clock-work by means of which rotation is given to a mirror, and so uniform and smooth is the movement that for hours together it follows the diurnal movement of the stars with such perfect accuracy that an observer looking into it sees reflected any sidereal object, which latter appears stationary to him while the mirror is moving. Great labor has been spent upon this instrument by Foucault, who has designed it, and by Eichens, who has recently finished its construction. This instrument, as mounted at the Paris Observatory, has been in constant use in experiments in photographing the sun; in fact, it ought to be the indispensable auxiliary of physical astronomy, since it allows the observer to direct his spectroscope or photometer, or other apparatus, steadily in the same direction, viz., toward the mirror, which latter only moves and reflects the sun's rays directly into the optical apparatus.—12 *A*, X., 358.

DIVISIBILITY BY SEVEN.

Professor Brooks, of Millersville, Pennsylvania, presents a number of curious rules relating to the divisibility of numbers by 7, of which the most general expressions are as follows: Any number divided by 7, 11, or 13 leaves the same remainder as is obtained when the sum of the odd numerical periods, minus the sum of the even numerical periods, is divided by these numbers. The converse of which is that any number is divisible by 7, 11, or 13 when the difference between the sum of the odd and even numerical periods is divisible by these numbers.—*The Analyst, July*, 1875, II., 129.

THE VARIABILITY OF TERRESTRIAL LATITUDES.

In a memoir on the determination of the latitude of the Royal Observatory of Capodimonte, at Naples, Fergola, after calling attention to a source of error in the instrument used by Brioschi in 1820, as in fact had previously been done by Peters, states that he has employed in his own more recent determinations one of the instruments employed by Brioschi himself, but has used it in an entirely different manner; and has, in fact, employed it only for determining the differences of the zenith distances of stars in the meridian north and south of the zenith. He states, as is so frequently done nowadays, that this method is originally due to Captain Talcott, of the United States Army; in which statement, however, Fergola has fallen into an error, as Horrebow and Hell had already applied this method over a hundred years ago, as have also numerous European astronomers since that time. The special interest that attaches to Fergola's new determination of the latitude of Naples consists in this, that his result is over one second smaller than that of Brioschi; and he calls attention to the fact that quite similar differences will be found in the latitudes determined at various times at the observatories of Greenwich, Washington, Milan, and Rome. —*Vierteljahrssch. Astron. Gesellsch., April*, 1875, X., 60.

SIMPLE METHOD OF DETERMINING LATITUDE.

A method of determining latitude without instruments, and with a considerable degree of approximation, is given by D'Avout; and, as it may sometimes be useful to travelers, we repeat it with some detail. Given a horizontal plane; above this plane, upon the same vertical and at known distances, are placed two points, whose shadows upon the horizontal plane can be followed. Around the common projection of these points, as a centre, two arcs of circles are described, whose radii are such that they can intersect the traces of the shadows of the points themselves before and after the meridian passage of the sun. The observation consists in measuring the chords of the arcs obtained by joining the intersections of the traces of the shadows with the circles; knowing the length of the chords, the radii of the arcs, and the heights of the points whose shadows are observed, we can, by a simple formula, calculate the latitude of a place. Either the two points whose shadows are projected may be two spheres, fixed upon the same vertical thread which traverses their centres, or we may use small circular openings pierced in metallic plates, and placed so that their centres are found on the same vertical. The shadows of these objects are small ellipses, whose centres may easily be found. The variation in the declination of the sun, between the afternoon and morning observations, occasions only a very small error, its effect being, in great part, eliminated from the final formula. The errors that may be made in measuring the various data above enumerated can occasion very small errors in latitude. The principal source of error is a possible want of exact horizontality in the plane on which the shadow is cast. In fact, an error of about two degrees in the inclination of this plane may produce an error of one degree in latitude. If, however, the plane be horizontal in a north and south direction, but incline in an east and west direction, the effect of the latter inclination may be neglected. The elimination of this latter source of error is due in part to the adoption of two points and shadows. The same advantages do not inhere in the employment of one point and one shadow.—*Bulletin Hebdomadaire*, XV., 578.

DETERMINATION OF LATITUDE AND TIME.

In a communication on the method of determining the time by means of two observed altitudes of any celestial body, Vice-admiral Von Wullerstorff-Urbair states that the method of determining the latitude by means of observations of stars, at equal zenith distances, was proposed and applied by him in 1848, at the Naval Observatory in Venice, but has in later times been widely adopted, and is known in America as Talcott's method. Admiral Von Wullerstorff-Urbair shows that the same system may be applied with accuracy to the determination of time; and quotes a note from Palissa, at the Naval Observatory at Pola, who says that this method was applied by him in December, 1873, and gives results whose value is equal to those deduced from the transit instruments. The method is specially to be recommended to travelers, since by means of the same theodolite both time and latitude may be accurately determined. The formulæ given by Von Wullerstorff-Urbair seem scarcely so convenient in practice as those taught for many years past by Dollen and the Russian geographers, and which were published in full some years ago by Smysloff.—"*Mitth.*" *Austrian Hydrogr. Off.*, II., 129.

THE COMPUTATION OF THE AREAS OF IRREGULAR FIGURES.

There often occurs a necessity for determining from a drawing the superficial contents of planes bounded by curved lines. This is the case, for instance, in the determination of the superficial contents of the water-lines of vessels. In such computations, ordinarily, we employ somewhat rude approximations, as in Simpson's or Stirling's methods. The latter author has given two methods: the first depending upon the principle that the portion of a curved line, between any two ordinates, may be considered as a portion of a parabola of the second degree. In the second method, given by the same author, the curve is considered as a portion of a parabola of the third degree. These three methods may be supplemented by other methods depending upon formulæ developed by Gauss, Cotes, and others. But in general all these methods are somewhat more difficult of application than that known as Simpson's, which is far more frequently employed than any other. A very decidedly better way has been proposed by the Russian mathematician, Tchebitcheff, whose method is simpler than either of those just mentioned, and, although less accurate than that of Gauss, is more accurate than those of Cotes, Stirling, and others. Indeed, a greater simplicity of application than this method offers is scarcely to be demanded, and its accuracy surpasses the ordinary necessities of the arts. In order to represent as closely as possible a curved figure by a series of polygons, Tchebitcheff takes six terms of the integral formula corresponding to six ordinates selected in the following manner: Let the surface be inclosed by the curved line A B C D, and the straight line A D; subdivide A D at E. The one half of A E, multiplied by the measured values of its ordinate, is then to be set off on either side of E, thus marking the places where new ordinates are to be measured, which are themselves to be multiplied by one half of A E; the products again set off on either side of E, and then a third pair of ordinates measured. In this way three pairs, or six ordinates, are obtained, whose values have a certain relation to each other and to the given curved line. The desired area is found by multiplying one sixth of the sum of these ordinates by the length of the line A E D. Other methods generally give results somewhat less than the truth. The method of Tchebitcheff generally gives larger results than the others.—"*Mittheilungen*" *Austrian Hydrogr. Office*, 1874, p. 530.

ASTRONOMICAL WORK AT CORDOBA.

In his annual report, as Director of the National Observatory of the Argentine Republic, for the year 1874, Dr. Gould states that the three principal undertakings of that observatory, viz., the uranometry, the zones, and the smaller catalogue of stars, have satisfactorily advanced toward their completion. An inevitable delay having occurred in the publication of the first mentioned of these works, the opportunity was seized to revise some portions of it—a revision which indicates that the accuracy attained is quite commensurable with Gould's original hopes and expectations. Having secured the necessary funds, it is now expected that in the course of the present year the publication of the charts will be completed. These will be thirteen in number, comprising the whole of the southern heavens. The total number of stars whose positions and magnitudes will be given will be not far from 8500. With reference to the zones of stars, he reports that some 12,500 additional observations have been made, bringing the total number up to 82,537. It is not improbable that the number of observations yet to be made will swell the total to more than 100,000; which work he then (March, 1875) hoped would be completed by the end of July, 1875. The greatest hinderance to the prosecution of this undertaking consists in the difficulty of securing the services of an adequate number of trained astronomical computers.

Of the large number of stars observed in these zones, a small portion have been selected as fit to form a special catalogue of brighter stars. This catalogue includes nearly 5000 stars, and some 12,400 observations upon these were made during the year. Dr. Gould adds that not one hour of unclouded sky between sunset and midnight was lost by his assistants during the whole time of his recent visit to the United States, notwithstanding that other observations were also going on by night, and continual computations by day. The equatorial telescope has been as busily employed as the meridian circle. Coggia's comet was observed from the 27th of July to the 18th of October. Standard Cordoba time has been given regularly from the observatory without a single case of failure; and latterly the exact Buenos Ayres time has been telegraphically transmitted to that city for the convenience of the shipping. Meteorological observations have been conducted and reported regularly to the Meteorological Office. Dr. Gould's corps of assistants has consisted of four persons, with occasional aid from others competent to act as copyists and computers. The assiduity of the labors of all concerned is abundantly testified to by the record of their results.—*Annual Report*, *March*, 1875.

PROPERTIES OF THE TETRÆDRON.

In an exhaustive memoir by Dostor on the application of determinants to certain problems in solid geometry, we find the following theorems relating to tetrædrons: The sine of a triedral angle is equal to the product of the sines of two of its faces, multiplied by the sine of the inclosed diedral angle. Again, in every tetrædron each face is equal to the sum of the products which we obtain by multiplying each of the three other faces by the cosine of its inclination to the first face. And, again, in every tetrædron the faces are to each other in the same proportion as the sines of the supplements of the opposite triedral angles. The volume of the tetrædron is equal to one sixth of the product of three contiguous edges multiplied by the sine of the triedral angles formed by these edges. Its volume may also be expressed as equivalent to multiplying one half of the product of two opposed edges by the sine of the angle comprised between them, and by one third of the shortest distance between these faces. In the regular tetrædron, the radius of the circumscribed sphere is triple the radius of the inscribed sphere.—*Grunert's Archiv*, LVII., 113.

ORBIT OF THE DOUBLE STAR 42, COMÆ BERENICES.

The star 42, *Comæ Berenices*, was discovered to be double in 1826 by the elder Struve, but it appeared single in 1833, since which time it has been observed regularly either by the discoverer or by his son, Otto Struve, as well as by other astronomers. Since 1826 it has four times presented the appearance of a single star, one of the bodies being actually occulted by the other. The very accurate observations of Otto Struve made since 1840, after having been corrected for the personal errors peculiar to his observations, and which have been most carefully investigated by himself, have sufficed to enable him to determine with very considerable accuracy the position and apparent dimensions of the relative orbits of these stars. The plane of their orbits coincides so nearly with the line joining them to the sun, that we can not certainly state that there is any appreciable inclination between the two. We have therefore to adopt 0° as the inclination between the line of sight and the orbit of the stars, and there results 11°, or the mean of all observed directions, as the angle between the ascending node and the declination circle. The remaining elements of the orbit of the stars, viz., the mean annual motion, the eccentricity, the major axis, the time of passage through the periaster and the angle in the orbit between the periaster and the ascending node, must all be deduced from micrometric measures of the relative distances of two stars. Observations of this nature are proverbially so difficult that up to this time astronomers have avoided employing them when position angles could be used instead. The great accuracy of Struve's micrometric observations, however, is fully illustrated by the remarkable agreement between the observed distance and those computed in accordance with the numerical values found by Struve for the time of revolution and eccentricity, and the other elements of its orbit. Of the thirty-eight positions given from 1827 to 1874, only two cases occur in which the discordances amount to one tenth of a second of arc; and these causes, it is promised, will be, at least in part, explained away in a forthcoming memoir relating to the peculiar systematic errors that attach themselves to the observations made by Otto Struve in 1840–41. Of the remaining thirty-six discordances, eight slightly exceeded one twentieth of a second of arc. The remainder are less than that quantity. The probable error of a single observed distance or the result of a single night's work is 0.046. Observations of these stars made by other astronomers agree satisfactorily with the orbit determined by Otto Struve, although the average of the discordances is somewhat larger in their observations than in his own.—*Notices of the Royal Astronomical Society, May*, 1875, 372.

METHOD OF CONSTRUCTING CHARTS OF STARS.

In constructing the new charts of the stars in the neighborhood of the ecliptic, the French astronomers, under the general direction of Le Verrier, have adopted some novel and excellent methods. The brothers Paul and Prosper Henry, in that portion of the work which they have performed, have made use of two equatorials, having apertures of about nine inches, and by a duplicate examination of each portion of the heavens have been able to discover many small planets and comets. The great equatorial of the observatory has been furnished with a micrometer of special construction, in which advantage is taken of the precision with which the telescope is made, by means of the regulator of Foucault, to follow the diurnal movements of the stars. This micrometer gives immediately the co-ordinates of any star comprised in the field of view of the telescope, with reference to a given standard point, and that in such shape that these figures may be entered directly upon the chart. This micrometer is also now being applied to the mapping of the individual stars in some of the clusters. The accuracy of the work done with this instrument is such that the star places given upon the charts are reliable within a second of time and one tenth of a minute of arc: a result somewhat surprising when we consider the extent of the work and the rapidity with which it is done. A portion of the zones will cross the Milky Way, and it will be attempted to give the position of every star visible in this region with the help of telescopes of ten inches' aperture.—*Bullet. Hebdomadaire*, 1875, 335.

ON THE RECTILINEAR RELATIVE MOTION OF THE COMPONENTS OF THE STAR 61 CYGNI.

Mr. Wilson has examined the relative motion of the components of the double star 61 *Cygni*, with the intention of ascertaining how far recent measures confirm Struve's conclusions that this motion is rectilinear. If these stars were physically connected in a binary system, it would be highly improbable that their apparent motions as seen from the earth would be sensibly straight lines. And yet, during the past century, the observations, which have been numerous, show that their motions really are so. On the other hand, the fact that they both have very large proper motions, being respectively 517 and 509 seconds per century, and in the same directions, leads to the conclusion that in all probability there must be some connection between them. We have thus the remarkable phenomena of two stars close together, animated by an unusually great proper motion, yet whose physical connection is still in doubt. Mr. Wilson's studies upon this subject seem not to contribute any thing toward a solution of our present doubts. He is merely able to confirm the fact that all known observations may be sufficiently well explained by the assumption that the two stars are moving in straight lines.—*Notices of the Royal Astronomical Society, April*, 1875, 324.

THE TRIPLE STAR ZETA CANCRI.

The triple star *Zeta Cancri* has for many years formed an object of study on the part of Otto Struve, who has recently published an excellent memoir on the relative movements of its components. The first observations of this star were by Tobias Mayer in 1756, who recognized it as double, and determined the relative position of the components. Similar observations were made in 1778 by Christian Mayer. Sir William Herschel, in 1781, made the interesting discovery that the principal one of the stars observed by Mayer was itself double; which observation was again confirmed, in 1825, by Sir James South. The three stars are nearly equal in brightness, and are ranked as between the fifth and sixth magnitudes; but whether the masses of the three bodies are really nearly the same can only be determined by their own movements, as deduced from such observations as have been made by William and Otto Struve. The former astronomer observed them first in 1826, since which time they have been closely followed by himself and son. The remarkably accurate observations of Baron Dembowski at Gallarate, near Milan, in Italy, together with those made by Dawes in England, have been by Otto Struve combined with his own; and from the entire assemblage of all the appropriate observations he finds that the apparent orbit of the star B about the star A is completed in about 62.4 years, under the assumption that the apparent orbit is circular, which appears to be very nearly the case (the real orbit has an eccentricity of 0.35). The third star of the group, indicated by the letter C, is apparently about ten times as far from A as is the star B. Its angular movement relative to the former star is therefore correspondingly slow, it having described only 47° in ninety years, while the star B has entirely completed its revolution and described a portion of its second orbit. An interesting peculiarity of the motions of the star C consists, however, in this, that its movements are by no means regular. It is in fact subject to repeated alternations within periods of about ten years, within which time it moves sometimes forward rapidly, and at other times backward, and at other times it is stationary. Its apparent orbit around the star A is therefore essentially an epicycloid; but unhappily the present state of mathematical analysis does not enable us to say whether these irregularities in its movement are due to the perturbing attractions of the stars A and B, or whether we must assume that the star C describes an elliptical orbit about an invisible point central between it and a fourth invisible star, D, while the central point itself describes a much larger orbit about the stars A and B. Otto Struve states that if we refer the positions of the star C to a point half-way between the stars A and B, we can closely represent all our observations by assuming C to move in a small ellipse, having a diameter of a third of a second, which latter is, at a distance of 5.5 seconds, carried uniformly about the point central between A and B.—*Bullet. Hebdomadaire Assoc. Scientifique*, 1875, 217.

ON THE CHEMISTRY OF THE SOLAR SYSTEM.

Observation and theory have led Lockyer to the conclusion that the various elements constituting the sun are arranged in layers according to the atomic weight of their vapors. Thus outside of all is hydrogen, with an atomic weight of one. Then follow, in regular order, magnesium, calcium, sodium, chromium, manganese, iron, nickel, etc. At the centre the nobler and rarer metals must be found, constituting the substance of the sun. In this same order should the nebulous mass have been arranged from which the solar system was developed, according to La Place's hypothesis, consequently the exterior planets of the solar system should be principally formed by the condensation of the metalloïds, and the inferior planets be composed of the metallic elements; thus Lockyer explains the feeble specific gravity of the former, and the greater mass of the latter planets. The composition of the atmospheres of the planets, which give only a few rays of absorption in the spectrum, seem to confirm this view of Lockyer. Even the composition of the outer shell of the earth would seem to accord therewith, since it is formed in the following proportion: Oxygen, 500; silicium, 250; the other metalloids, 227; and of other simple bodies, 23 parts out of a thousand. If, on the other hand, we add the liquid portion of water, it will be found that hydrogen enters in a still larger proportion, and, with oxygen, acquires a predominance; so that it may be said our earth is composed principally of oxygen and hydrogen, with a small percentage of metals and metalloids.—*La Nature*, III., 206.

A FAMOUS SOLAR ECLIPSE.

The total solar eclipse of the 3d of June, 1239, was a memorable event in Central Europe, and has formed the subject of an interesting memoir by Celoria, one of the astronomers at the Observatory of Milan. This gentleman has collected together all the accessible notes with reference to observations made at that time upon the eclipse, from which it appears that the line of central totality passed through Northern Italy and Southern Spain. Our author has sought, by a very careful discussion of the observations at command, to determine the precise northern limit of visibility of the total eclipse; and, by comparing the observations with the tables of Hansen, to deduce some positive addition to our knowledge of the secular changes in the orbit of the earth and moon. He expresses his results by an equation which shows that we need but one more similar eclipse in order to arrive by means of a second such equation at more correct elements of the lunar orbit.—*Publication of the Royal Observatory, Milan*, No. 10, 1875.

STUDIES UPON THE DIAMETER OF THE SUN.

As the extensive work of Father Rosa upon the solar diameter is likely to provoke much further investigation of this subject, notwithstanding all that has been done by Auwers, Wagner, Newcomb, and many others, we quote the following conclusions to which he has been led, as published in the posthumous work recently edited by Father Secchi. First, the body of the sun must be considered as composed of two masses nearly independent of each other, viz., of a solid nucleus enveloped by a gaseous matter. The expression "solid nucleus" can even be applied to the central portion of a gaseous mass whose condensation is such that it is necessary that it should be nearly independent of its envelope. Second, the deformations of the photosphere are not due directly to the force of gravity. Third, the continuous force, that which especially deforms the photosphere, is connected with that which produces actual secular movements of the centre of gravity of the sun as demonstrated by Le Verrier. Fourth, the vertical diameter of the sun experiences an annual variation or a semi-annual period, such that it is greater when the sun is north of the equator. Fifth, the mechanical theory of the sun's motions demands that its centre of gravity should describe, in its apparent movement, a great circle of the celestial sphere. The centre of figure, according to Airy, describes a parallel circle, lying northward therefrom. Sixth, it results evidently from the two preceding sentences that the plane of the ecliptic is not parallel to that which cuts the photosphere into two symmetrical parts. Seventh, it also results that the mean accumulation which is produced at the extremities of the diameter of the photosphere takes place instantly by preference in the northern hemisphere. Eighth, it seems, then, probable that a larger quantity of the gaseous mass may be suspended in the northern than in the southern hemisphere. It must be that this accumulation occasions the excess of temperature in the northern hemisphere, and opposes therein some resistance to the manifestation of the interior activity of the sun. Father Rosa finally concludes that the secular variations of the photosphere and of terrestrial magnetism are simultaneous, and subjected to an oscillation of 66⅔ years, similar to that which the apogee of the apparent orbit of the sun is subject to. We can thus consider our sun as making a part of a triple stellar system, in which the interior star combines with our sun in a movement about the same centre, whose period is 66⅔ years.—*Biblioth. Univers.*, 1874, 259.

SOLAR RADIATION IN EGYPT.

M. Picte has communicated several series of observations which he has had occasion to make during a prolonged sojourn at Cairo, as director of the Physical Cabinet of that city, and among them he has made some measurements of solar radiation with a large actinometer. His apparatus consisted of a sort of boiler, of two thin plates of parallel sheet iron, filled with water, placed in a chest full of black cotton, and closed over its face, which was turned toward the sun, by a comparable number of plates of glass. As a result he finds that, in Egypt, a surface of one square meter exposed normally to the rays of the sun in the middle of the day absorbs very nearly twelve calories or units of heat per minute. Other observers, also operating in Egypt, have found about ten calories. The diurnal evaporation produced by the action of the sun is one sixth of an inch of water. The evaporation which is due to the dryness of the air and to the wind is one third of an inch.—*Biblioth. Univers.*, 1874, 484.

THERMOGRAPHS OF THE ISOTHERMAL LINES OF THE SOLAR DISK.

Professor Mayer announces that he has devised a method for obtaining the isothermals on the solar disk, by which invention he thinks it possible that an entirely new branch of solar physics may be created. He causes the image of the sun to fall upon the smoked surface of thin paper, while the other side of the paper is coated with a film of Meissel's double iodide of copper and mercury. When the wave of heat, passing through the carbon and the paper, has warmed the thin film of iodide to the temperature of 70° Centigrade, this substance is blackened; and if, beginning with a very small aperture of the telescope, we gradually increase it until we obtain the smallest area of blackened iodide that can be produced with a well-defined contour, we thus obtain a determination of the area of maximum temperature on the solar disk. On using a larger aperture of the object-glass of the telescope, a larger surface of blackened iodide is formed, the new area being bounded as before by a well-defined isothermal line; and by repeating this process maps are obtained of the isothermals of the solar disk. An exposure of about twenty minutes is required to obtain these thermographs, which are sufficiently permanent to allow one to trace accurately their isothermal contours. But other substances exist which are more suitable than the iodides for producing permanent thermographs. Professor Mayer states that, as far as he has at present applied this method, he concludes that there exists on the solar disk an area of sensibly uniform temperature and of maximum intensity. This area of maximum temperature is of variable size. It is in motion on the solar image. It is surrounded by well-defined isothermals. The general motions of these isothermals follow the motions of the central maximum area, but they have also their independent motions.—*American Journal of Science, July*, 1875, 50.

A NEW METHOD OF COMPUTING PLANETARY PERTURBATIONS.

The immense amount of labor that has, for a hundred years past, been spent upon the computation of the mutual perturbations of the planets, and the great amount of time and ingenuity employed by mathematicians in devising the methods of special perturbations and mechanical quadratures, would justify a prolonged notice of the new method of computing special perturbations developed in a recent memoir by Professor Gylden, of Stockholm, and which has been applied by Backlund to the computation of the movements of the asteroid Iphigenia. The original method consists in integrating the differential equations of perturbations, according to analytical methods, instead of by mechanical quadratures; Gylden's idea appears to lead to as simple forms of computation as the older methods, but possesses several great advantages, especially in the checks upon the accuracy of the computation at every step of the process. By means of analytical formulæ developed by him some years ago as preliminary to the present work, he is able to express the co-ordinates as well as the sines and cosines of the co-ordinates of the perturbed bodies in rapidly converging series. Dr. Backlund, in applying Gylden's method to the computation of the special perturbations of Iphigenia, has taken account only of the disturbances introduced by Jupiter during three semi-revolutions of the asteroid. He divides the orbit of the planets into sixteen equiangular portions of twenty-two degrees each, for each of which the perturbations are independently computed.—*Vierteljahrsschr. Astron. Gesellsch.*, X., 36.

GALLE'S PATH OF THE METEOR OF JUNE 17, 1873.

The orbit of the bright meteor observed in Austria and Germany on the 17th of June, 1873, has been carefully investigated by Professor Galle. Having satisfied himself that the end of the visible path of the meteor was not far from Zittau, he made a special examination of that region, and gathered many observations which enabled him to fix the actual position of the meteor at the time of its disappearance, and was even able to gather some of those fragments which reached the earth, although their actual fall was not observed by any one, and the connection of the supposed fragments with the original mass is subject to some doubt. In the computation of the orbit, Professor Galle proceeded according to the method elaborated by him as most appropriate to such cases, as follows:

Having determined definitively the exact position of the end of the orbit, each observer's observation then enabled him to determine the apparent plane of motion, the intersection of which planes determined the position of the path followed by the body. Among the thirty-three excellent observations which he was able to use in his study, only two or three were discordant from the others to such an extent that but little weight could be attributed to them. The linear length of the visible path in the atmosphere was sixty-two geographical miles, the initial point of which was twenty-two miles above the earth's surface, while its end was four and a half miles high. The meteor moved nearly in the plane of the ecliptic, and was approaching the sun at the time that it passed through the earth's atmosphere, cutting the earth's radius vector at an angle of forty-five degrees, the curve of its orbit being that of a hyperbola, and its velocity being somewhat slower than that of the ordinary shooting-stars. The detonation that accompanied this meteor was heard to a distance of forty miles, being most intense in the neighborhood of the end of its path, where at nearly every station it was reported as like the long rolling sound of thunder.—*Jahresbericht der Schlesischen Gesellschaft*, 1874.

TWO GROUPS OF NOVEMBER METEORITES.

Professor Kirkwood, of Indiana, communicates to the English journal *Nature* some remarks on the meteors of November 14, known as the Leonids, because their radiant point is in the constellation of Leo. According to Professor Kirkwood, there are indications of the existence of two distinct and widely separated clusters of meteors moving in orbits very nearly identical, and having therefore very nearly the same radiant point. The principal cluster is that whose appearance at intervals of 33¼ years was first demonstrated by Professor Newton, while the second group, according to Kirkwood, has a period of 33⅓ years. He suggests that if these two clusters are originally derived from the same meteor cloud, then there must have been a considerable disturbance in their orbits caused by the attraction either of Uranus or of the earth. He cites nine recorded displays of meteors indicating the existence of the second cluster. The first of these occurred in the year 288, and was observed in China on the 28th of September.—12 *A*, XII., 85.

ENCKE'S COMET.

Dr. Van Asten, already known by his profound investigations into the movements of Encke's comet, announces that, having lately come into the possession of a number of observations of this object, he hopes to deduce something definite in reference to the peculiarities of its orbit. It is well known that Encke himself believed this comet to be gradually drawing nearer to the sun, in consequence of the resistance offered to its movements by the æther existing throughout space. Van Asten, however, states that his investigations have led him to the surprising result that the observations of 1865 to 1871 can be perfectly accounted for by the general laws of mechanics, quite without calling to our assistance the attractions of unknown bodies or the resistance of an unknown æther. If, under this assumption, we reverse the problem, and attempt to deduce the movements of Jupiter from observations of Encke's comet, we arrive at a result quite identical with that deduced by Bessel, Kruger, and Moller, so that we may be certain that the mean motion of the comet, at the time of its perihelion passage in 1868, experienced not the slightest trace of an acceleration. The assumption that it did experience such an acceleration, even the one-twentieth part of that supposed to exist by Encke, leads to very improbable errors. Van Asten lays stress upon the date, 1868, and says that while at present the comet's motions are fully explicable, yet, if we extend our researches backward, it does seem highly probable that at its perihelion passages in 1858, 1862, and 1865 the comet did successively experience accelerations nearly agreeing with Encke's suppositions. The conclusion, therefore, seems reasonable that the most remarkable feature of this phenomenon is the complete absence of any acceleration at the perihelion passage of 1868; nor can this be explained on the supposition that the disturbing influence of the planet Mercury has been different from that assumed in the calculations. As there can be no doubt that the comet experiences an extraordinary perturbation in the immediate neighborhood of its perihelion, Van Asten explains that he has, for simplicity, made the preliminary assumption that this acceleration took place suddenly at that time; an hypothesis, however, which is not materially different from Encke's assumption that the comet moves in a resisting medium, whose density varies inversely as the square of the distance from the sun; for, if its density vary according to this law, its effect upon the comet would be mainly felt during twenty-five days before and after the perihelion. At the appearance of this comet in February, March, and April, 1875, Bredichin, at Moscow, and Struve, at Poulkova, were successful in making observations which are best accounted for by assuming an acceleration since 1871 of about two thirds as much as that indicated at previous apparitions, as though the physical changes in the interior of the comet which occurred in 1868 had affected not only its movements at that time, but also, in a lesser degree, are continued to the present time.

ON COMETARY ORBITS.

In giving a general review of the statistics relative to the orbits of comets, Guillemin states that 177 have parabolic orbits, 73 elliptic, and 14 hyperbolic. To these must be added a large number of other comets not yet accurately computed, so that we may calculate that of these bodies scarcely one sixth are foreign to the solar system, and the remainder circulating about the sun as do the planets. With regard to the inclinations of their orbits to the orbit of the earth, he shows that the greater inclinations are more frequent than the lesser; so that the comets whose paths are confined to the zodiac form scarcely a quarter of those that are known. As regards the direction in which they move in their orbits about the sun, the direct and the retrograde motions are about equally divided. But if we examine in detail the three classes—the parabolic, the elliptic, and the hyperbolic orbits—we find that among the elliptic orbits the direct motions are twice as numerous as the retrograde. As regards the distance to which they approach the sun, 192 have come between the earth and the sun, and 66 between the earth and Jupiter; while between the orbits of Venus and Mars not less than 130 of these have passed. —*Bulletin Hebdom. Association Scientifique*, 1875, 262.

ON THE STRUCTURE OF COMETS AND METEORS.

From an examination of the gases occluded in the Iowa meteorite of February 12, 1875, Professor Wright, of New Haven, concludes that his results have an important bearing upon the theory of comets and their tails, warranting the following conclusions: First, the stony meteorites are distinguished from the iron ones by having the oxides of carbon, chiefly the dioxide as their characteristic gases, instead of hydrogen. Second, the proportion of carbon dioxide given off is much greater at low than at high temperatures, and is sufficient to mask the hydrogen in the spectrum. Third, the amount of gases contained in a large meteorite, or cluster of such bodies serving as a cometary nucleus, is sufficient to form the train as ordinarily observed. Fourth, the spectrum of the gases is closely identical with that of several of the comets. We may, then, he states, consider a comet merely as a meteorite of considerable magnitude, or a swarm of many such of lesser size, containing large quantities of carbon dioxide, with some carbonic oxide and hydrogen, and giving off this gas under the influence of solar heat. The gaseous substance in streaming away forms the train which is visible, partly by reflected sunlight, and partly by its own light, due to some molecular or electrical action which causes it to give the spectrum of the carbon compounds. The loss of the gaseous contents readily explains the loss of the tail and diminution of brightness, observed in the case of several comets in their successive revolutions.—*Silliman's Journal, July*, 1875, 48.

THE DISTRIBUTION OF COMETARY ORBITS.

Guillemin calls attention in his new work on comets to a feature in the distribution of the orbits of these bodies, which consists especially in the fact that there are special regions of the heavens in which the cometary aphelia are more thickly crowded together than in other regions. Basing his studies upon those of Hoeck, of Utrecht, he places the region within which the least number of cometary aphelia is found in the sector comprised between the ecliptic and a circle inclined thereto at an angle of about 35°, and cutting it in the longitudes 95° and 243°. In explanation of this singularity, Hoeck suggests that if the point toward which the solar system is moving in its great motion of translation occupied the middle of this sector, it would follow that the comets coming from this region would have greater difficulty than any others in following and rejoining the sun. But the direction of the movements of the solar system is such that it does not favor this explanation. Guillemin suggests, therefore, that possibly this sector corresponds to a region of the heavens essentially deficient in cometary emanations, although possibly the deficiency of cometary aphelia in this region may depend, to some extent upon the fact that the atmospheric conditions in July and December are unfavorable to the discovery of comets in that part of the ecliptic. The first of these suggestions, however, will be seen to have some probability, if we consider that Sir John Herschel, who has worked on the distribution of the nebulæ, has shown that the various regions of the heavens are very unequally favored as regards the actual quantity of nebulous matter; and a similar inequality in the distribution of those nebulous centres whence comets emanate might from analogy be reasonably expected.—*Bullet. Hebd. Assoc. Scien.*, 1875, 234.

BRUHNS ON POGSON'S AND BIELA'S COMETS.

The return of Biela's comet in 1872 was, as will be remembered, looked forward to with great interest, and some disappointment even was felt that it continued invisible to the most powerful telescopes employed in the search for it. Under these circumstances, a faint interest was awakened by the fact that on the 27th of November one of the most beautiful showers of shooting-stars was observed, and that, too, in such a position that it seemed probable that these meteors were moving precisely in the orbit of Biela's comet. There was, therefore, a strong presumption that an intimate connection existed between the two phenomena. Klinkerfues, of Göttingen, suspecting that, in fact, the two might be identical, telegraphed to Pogson at Madras, on the 30th of November, the following dispatch: "Biela touched the earth November 27. Search near *Theta Centauri.*" Following the suggestion of this dispatch, Pogson searched, and found a comet near the predicted spot, but was successful in observing it on only two days—the second and third of December; and for some time the impression seems to have prevailed among astronomers that he must have actually observed Biela's comet. His observations, however, have been carefully discussed by Oppolzer, and now recently more thoroughly by Bruhns. Oppolzer and Klinkerfues agree that Pogson's comet was really in the most intimate connection with the star shower, and possibly was really the head of Biela's comet. Bruhns, however, seems conclusively to show that Pogson's observations can not possibly be made to agree with the orbit of Biela's comet, as computed by Michez; and that it is very probable that the object observed by Pogson is a new comet having no connection either with Biela's or with the shooting-stars.—*Vierteljahrsschrift Astronomische Gesellschaft*, X., 162.

LORD ROSSE'S THREE-FOOT TELESCOPE.

Those who are interested in large telescopes will perhaps not have forgotten that Lord Rosse has for a long time possessed, not only his immense telescope of six-feet aperture and fifty-six feet focal length, but also a smaller telescope of three-feet aperture, whose space-penetrating power must be equal to, if not superior to, that of any refracting telescope which has yet been constructed. Mr. Dreyer, in a review of the observations of nebulæ made by Dr. Schultz, states in a note that the observations of nebulæ which have been made at Birr-Castle by Lord Rosse, almost without interruption since 1860, have been, within the last few years, made, not as formerly in order to procure exact sketches and descriptions of more interesting objects, but to give measures of positions and distances of as many stars as possible in the immediate neighborhood of the nebulæ in Sir John Herschel's general catalogue. The distances are observed with occulting bars, so that the faintest stars can be observed. The six-foot reflector is, however, so mounted that the observer can follow an object near the equator only for about thirty minutes, and this causes great inconvenience in the conduct of the work they have in hand. He states that the three-foot reflector will, in a short time, be mounted as an equatorial, and will in the winter of 1875–76 be used to complete a series of special observations of nebulæ made since 1860, and whose publication may be expected in one or two years.—*Vierteljahrsschrift Astron. Gesell.* X., 66.

ON THE ELECTRIC DISCHARGES IN THE AURORA BOREALIS.

An extensive series of observations on the aurora by Lemström in 1871, during a journey into Lapland, and published recently by the Helsingfors Academy of Sciences in Finland, has become accessible to us through a translation by the author, who sums up the results of his work, and that of others, as follows: First, the luminous phenomena, or flames, seen about the summits of the mountains of Spitzbergen, are also seen in Lapland, and are of the same nature as the aurora borealis. Second, some phenomena of the same kind, although a little different, have been observed in other countries; and this proves that electric discharges of the nature of the aurora can take place elsewhere than in the arctic regions. Third, the spectroscope is the surest means of deciding, in case of doubt, as to the nature of the phenomena. Fourth, in arctic countries the electric discharge preceding thunder passes through the atmosphere at a lower altitude than in any other countries. Fifth, the electric currents which are developed in the earth when the aurora takes place are not phenomena of induction governed by the latter—at least not in the northern regions. If they are not caused by the same current which is produced by the transportation of electricity from the upper regions of the atmosphere toward the earth, it is necessary to seek their cause in the perturbation of the terrestrial current. Sixth, in all probability the currents attending the aurora should be able to affect the galvanometer, provided that the apparatus which collects the electricity is sufficiently large, or placed sufficiently high in the atmosphere. Seventh, as a rule, the positive electricity of the aurora comes from above, downward. Eighth, the corona of the aurora is only a perspective phenomenon; but the rays themselves have a real curvature. Ninth, in the spectrum of the aurora there are in all nine rays, which, in all probability, are the same as the lines given by the gases that compose the atmosphere. Tenth, the spectra of the aurora can be classified in three different types, which depend upon the character of the discharge itself.—*Bibliothèque Universelle*, L., 1874, 385.

COMPENSATION OF CLOCKS FOR THE INFLUENCE OF BAROMETRIC CHANGES.

In the new standard sidereal clock of the Royal Observatory at Greenwich, a peculiar arrangement has been introduced in order to counteract the influence upon the rate of the clock of the varying density of the earth's atmosphere. This density, as it is well known, varies principally with the changes in barometric pressure; and Professor Airy has therefore established within the case of the clock a siphon barometer, on whose open end floats a rod whose rise and fall with the varying atmospheric pressure moves a horizontal lever at whose opposite extremity is supported a vertical magnet. The corresponding falling and rising of this magnet, which is placed directly under the pendulum, causes a variable magnetic attraction to be exerted upon the latter; so that with increasing density an increasing force of gravitation is, as it were, brought to bear upon the pendulum, thereby slightly accelerating its movements and counteracting the retarding influence of the atmosphere. Without this arrangement it was found that a fall of one inch in the barometer caused an increase in the daily rate of the clock of about three tenths of a second. The application of the graduating magnet has also had a further advantage in causing the arc of vibration to be sensibly constant at all times.—12 *A*, XI., 431, *and Ann. Rep. of Astronomer Royal.*

RESULTS OF THE AMERICAN AND OTHER OBSERVATIONS OF THE TRANSIT OF VENUS.

At the time of going to press with our last annual volume, there had not been time to obtain precise information respecting the success of the various parties sent out to observe the Transit of Venus. We therefore give now a brief account of the measures taken by our government with this object, as well as of those of other nations, and an estimate of the measure of success attained.

As our readers may be aware, the American parties were organized and sent out by a commission, composed of the Superintendent and two professors of the Naval Observatory, the President of the National Academy of Sciences, and the Superintendent of the Coast Survey. All the responsibility for the American system of observations rests with this commission, which was created partly in order to secure the harmonious co-operation of those departments of the government which took an active interest in the matter. In this respect the plan was entirely successful. Of the eight parties organized, one was an army party, in which the chief and assistant astronomer were officers of the Corps of Engineers of the army. Besides this, the same corps furnished the assistant astronomer for another party. There was also a naval party, in which the corresponding officers were officers of the navy. The Coast Survey furnished the astronomers for two parties, and the Observatory furnished the chiefs for two more. The two remaining chiefs were distinguished civilian astronomers, each the director of an observatory.

The plan of observation adopted by the commission was in many respects different from that used elsewhere, being worked out quite independently. Its distinguishing features were that the observations should be made on the same plan at all the stations, that the main reliance should be placed on photographs of the phenomena, and that these photographs should be taken on a peculiar plan. The essential feature of the plan is that the image of the sun is thrown into the photographic dark room by being reflected from a flat mirror, the rays after reflection passing through a lens of forty feet focal length. This lens is so adjusted that the image is formed on the photographic plate, which is firmly mounted on an iron pier in the dark room. This plan is extremely convenient in photographing, and one of the best illustrations of its advantages is found in the fact that at not a single one of the stations was there any mishap which interfered with the taking of the photographs during the critical moments of the transit. Another circumstance worth noting is that the entire apparatus was of American manufacture, the most important part being made by Alvan Clark & Sons. The success of these ingenious artists with the mirrors of the photographic apparatus was especially gratifying, as it was absolutely necessary to the success of the plan that these should be made with a degree of perfection which European astronomers feared might be unattainable.

As stated in our previous volume, the Americans occupied three northern and five southern stations, an unequal division between the two hemispheres being made because the chance of good weather was much greater in the northern hemisphere than in the southern, and it was desirable to have as nearly as possible an equal number of observations on the two sides of the equator. The northern parties, with their material, were sent from San Francisco to Nagasaki by the Pacific Mail steamships, whence two of them were distributed to their stations by naval ships, one remaining in Nagasaki. The southern parties were distributed among the stations by the U. S. steamer *Swatara*, Captain R. Chandler, which sailed from New York June 7, 1874, and visited the five southern stations in succession.

The northernmost station was Vladivostok, a new seaport of Siberia on the Sea of Japan, lat. 43° N., long. 132° E. of Greenwich. The chief of the party was Professor A. Hall, of the Naval Observatory, Mr. O. B. Wheeler, of the Lake Survey, being assistant astronomer. The party sailed from San Francisco in the *Alaska* on July 28, and finally reached Nagasaki on August 30. Here they went on board the U. S. steamer *Kearsarge*, which conveyed them to Vladivostok. This port was established by the Russian government about 1868, more to strengthen its position in this quarter than on account of any commercial advantages. It was therefore made into a military post, with a military government. The violent winds and intense cold which prevail at this port during the winter rendered much exertion necessary to prevent the light portable observatories which the party had carried from home from being blown away entirely, and to keep the photographic house warm enough to be used. Some difficulty was found in making the instruments work well at so low a temperature as sometimes prevailed, but they were all overcome before the day of the transit. When this eventful time arrived, instead of the perfectly clear weather they had every reason to expect, the sky was covered with a thin haze, which continued during the entire four hours of the transit. In consequence it was found exceedingly difficult to obtain good photographs. Thirteen were taken; but the image of Venus is so faint that great pains will be required to determine its position with the necessary accuracy. The haziness did not interfere so much with telescopic observations as with the photographs, so that the astronomers succeeded in observing three out of the four contacts.

Pekin.—At this station Professor James C. Watson, of Ann Arbor, was the chief of the party, and Professor C. A. Young, of Dartmouth College, assistant astronomer. The record of the weather at Pekin during the month of December for a number of years showed a remarkable freedom from clouds, an entirely cloudy day being almost unknown.

The night before the transit was beautifully clear. At 4 A.M. Professor Watson went to the observatory, observed for some time, and made a final inspection to see that all was right. Every man was in his place long before the appointed time. But just as the party were taking the preliminary photographs a bank of clouds came up from the southeast and covered the sun, so that the prospect seemed almost hopeless. Fortunately openings in the clouds permitted the first two contacts to be observed, and by watching for other openings the party succeeded in securing forty-four photographs. Then it clouded up completely for a period. At one o'clock it partially cleared away, so that more photographs could be taken. But one of the most annoying peculiarities of the Pekin climate, a storm of dust, was approaching, so that the photographs were very faint, owing to the yellow tint of the sun. Still the observers succeeded in observing the two last contacts, so that all four contacts were successfully observed. This was the only American station which had this good fortune.

Nagasaki.—This was the remaining northern station occupied by the American parties. Mr. George Davidson, of the Coast Survey, was chief of the party, and Mr. Titman, of the same establishment, assistant astronomer. The weather here was much the same as at Pekin, the photographs being taken through occasional openings in the clouds. Three out of the four contacts were observed, one being somewhat doubtful. About sixty photographs were taken, most of them very thin, owing to the haziness of the atmosphere. It was somewhat tantalizing to learn that, while all three of the American stations in Asia suffered from clouds and haze during the critical hours of the transit, the German station at Tchifu, near the centre of the triangle formed by the three American stations, enjoyed a perfectly clear day.

In the southern hemisphere our commission established one station at Kerguelen Island, two in Tasmania, one in New Zealand, and one on Chatham Island. Kerguelen Island is a barren and most inhospitable mass of volcanic rocks, about 2500 miles southeast of the Cape of Good Hope. It is almost totally devoid of the higher forms of vegetable life, the most conspicuous plants being certain mosses and a so-called cabbage discovered by Captain Cook. The party which spent three months on this barren spot was headed by Lieutenant-commander George P. Ryan, U.S.N., with Lieutenant-commander Charles J. Train as assistant astronomer. The region is one of the stormiest on the globe, and although the transit occurred at the finest season of the year, an entirely clear day is almost unknown. But on most of the days there are openings in the flying clouds driven past by the western storms, and as the station was, astronomically, the most favorable in the southern hemisphere, the chance of getting a good collection of photographs between the clouds was judged sufficiently good to justify its occupation. Although the result justified this opinion, it was perhaps a simple piece of good fortune, for storms succeeded each other in such rapid succession that the party had the greatest difficulty in keeping their tents and houses from being blown away. The *Swatara* actually lost her steam-launch in one of these storms.

On the morning of December 9 the sun rose clear, and as the entire transit was to take place in the forenoon, great hopes of success were entertained. Commander Ryan succeeded in obtaining a fine observation of the first contact of the planet with the sun's disk. But clouds then arose, and continued to fly across the sun during the remainder of the transit. By watching their chances, the photographers succeeded in getting twenty-six good photographs of Venus on the sun, so that their operations were on the whole successful.

The Germans and English also had quarters on Kerguelen Island. By an unfortunate combination of circumstances the three parties were all on the east end of the island, and so near together that they all had the same kind of weather. A year or two before the transit the English authorities had selected as their station Christmas Harbor, on the northern side of the island, which had several times been visited by their ships. The American Commission had selected Three Island Harbor, in the extreme southwestern portion of the island, principally on account of its being occupied as a sealing station by the ships of Messrs. Williams, Haven, & Co., of New London, Conn., and being as far from the English station as it was convenient to get. During the summer of 1874 the island was visited by H. M. S. *Challenger*, which examined both stations, and reported to her government that Three Island Harbor offered the best chances of fine weather, on account of being on the leeward end of the island. The change was not known to the American party until the *Swatara* reached Cape Town, where the English party had already arrived. On comparing notes it was found that both parties were bound for the same part of the island. The most tantalizing part of the result was that the station which all the parties avoided was reported to have enjoyed a beautiful day on the 9th of December.

The *Swatara* proceeded from Kerguelen to Hobart Town, Tasmania, or Van Diemen's Land, as it used to be called, and there landed two parties. One of these was in charge of Professor William Harkness, of the Naval Observatory, and the other in charge of Captain C. W. Raymond, of the Corps of Engineers, U.S.A. The latter party was designed for Crozet's Islands, a group some distance west of Kerguelen; but when the *Swatara* arrived there it was found impossible to effect a landing, owing to a sudden storm which blew the ship so far away that she could not return to the island and land the party without spending so much time as to endanger her reaching the other stations in season for the observations.

The meteorological reports from Hobart Town for the month of December in previous years had been so favorable that this was regarded as the best station in the southern hemisphere. But the whole season proved stormy in the extreme, so that it was with the greatest difficulty that the astronomers could get observations enough to rate their clocks and chronometers. At Hobart Town Professor Harkness had very bad weather on the day of the transit; indeed, there was heavy rain during a considerable portion of the time that Venus was in transit. But he succeeded in getting about ninety photographs by taking advantage of openings in the clouds, so that he had no cause to be dissatisfied with his results. Captain Raymond's party was at Campbell Town, about a hundred miles north of Hobart Town, where both the weather and the results were very much the same. Fewer photographs were obtained, but Captain Raymond secured a good observation of internal contact at egress.

The chief of the New Zealand party was Professor C. H. F. Peters, of Hamilton College, with Lieutenant E. W. Bass, of the Corps of Engineers, as assistant astronomer. The station originally designed for him was Bluff Harbor, at the extreme southern end of the southernmost large island. But on reconnoitring the ground, it was found that the chances of clear weather were better on the high lands of the interior; the station was therefore finally chosen near Queenstown. The change proved to be very fortunate. Both at Bluff Harbor, in the south, and at the English station at Christ Church, it was cloudy or raining during the whole of the transit, so that the English observers did not catch a glimpse of it, while Dr. Peters had so much clear weather as to obtain a very fine collection of photographs. But it was cloudy both at the beginning and end of the transit, so that he got only one of the four contacts.

The easternmost of the southern parties was that of Mr. Edwin Smith, of the Coast Survey, with Mr. Scott as first assistant, and was stationed at Chatham Island. This party suffered the worst of all from unfavorable weather on the day of the transit; only a few glimpses of the sun were obtained, by utilizing which the party took six or eight successful photographs.

It will be seen that the weather at the American stations was very remarkable in one point: at not a single station did the operations entirely fail through cloudiness, while they suffered, more or less, from this cause at every station. That it should have been partly cloudy at all three northern stations was a great disappointment, yet the number of available photographs in the two hemispheres is very nearly equal. The eccentricity of the weather seemed to show itself in a playful manner by favoring those places where the chances of fine weather had been found to be the least. Mr. Janssen, the celebrated French spectroscopist, who went to Japan to observe the transit, had fixed upon Yokohama as his station. On arriving there he learned that the American commission had for two years caused meteorological observations to be made at Yokohama and Nagasaki, which showed the latter to be the most favorable station. He therefore moved thither with his instruments, occupying a station two or three miles distant from Mr. Davidson's. When the day of the transit arrived, the "probabilities" were set at defiance by the weather at Yokohama being finer than at Nagasaki.

What the public now have to look forward to is the final result of all these expeditions; and this is something which we regret to find there is no immediate prospect of learning. No nation has yet made any official publication even of its observations. The fact is that the observing parties have brought home an immense mass of material, the working up of which requires much consideration and great labor. The greatest accuracy must be sought after at every step, and any attempt to push through the complicated operations which are necessary so as to obtain immediate results would be entirely futile. In order to compare the times of the observations in the two hemispheres the longitudes of all the stations must be known. Observations for this purpose were made by the parties; but to calculate the results is a much slower and more difficult process than to make the observations. Another tedious work will be the reading of the photographic negatives. The computation of the contact observations will be easier; indeed, a French mathematician has actually published a result (8.87″ for the solar parallax) from the observations of a single pair of stations. But a result of this sort is hardly better than guess-work; and, as it is said that the other results of the French observations are different, we may fear that the above result was published only because it came out about right. Altogether, we fear it will be two or three years before the observations by each nation are worked up ready for publication; and when this is done, it will only furnish the data from which some mathematician will deduce the final result. Even then every thing will be carried through much more rapidly than in the case of the transit of 1769, notwithstanding that, owing to the more refined modern methods, the labor of working up the old observations was much less than must be devoted to the recent ones.

ON THE OBSERVATION OF VARIABLE STARS.

A second catalogue of variable stars, with valuable notes relating thereto, has just been published by Schönfeld, whose first catalogue, in 1866, with the additions of 1868, is already well known to the few astronomers who are sufficiently interested in this subject to institute observations upon these objects. To Argelander, Schmidt, and Schönfeld is due the greater part of the credit of having advanced our knowledge of the variability of the brightness of stars to its present degree of precision. It seems to be unfortunate that so very few astronomers occupy themselves with this portion of observational astronomy, the neglect of which, in fact, seems entirely unjustifiable. The conclusions in reference to the physical condition of the stars that may be attained by observations of the variable stars are so related to those derivable from the analysis of their light made by means of the spectroscope that it is surprising that the older sister of these two branches of observation is, in these later times, so much neglected.—*Vierteljahrsschrift der Astron. Gesellschaft*, X., 74.

TIME ARRANGEMENT AT PITTSBURGH.

In his account of the very perfect arrangements at Pittsburgh for the regulation of the city time, Professor Langley states that, by the discrepancies of clocks and watches, the amount of time wasted is in the aggregate very considerable, and is indirectly felt by every individual, making it a public convenience to have a simple and universally accessible means of obtaining standard time throughout the community. The arrangements devised by him for doing this are in some degree peculiar to Pittsburgh, which is as yet in advance of all other American cities in this respect. The astronomers at the Observatory in Allegheny City having accurate time for conducting their observations, it was only necessary to secure some means by which this time could be reliably and widely distributed. Electricity was called in to do this, a current being automatically sent from the observatory clock to the large tower clock in the City Hall at every beat of the seconds pendulum, and by an electro-magnetic arrangement in the turret that clock is caused to beat in perfect unison with the standard at the observatory; it also automatically gives notice to the observatory if it is in error to any extent. At the exact second of noon a special current is sent, which raises a detent, and allows a hammer to strike the large bell at the proper instant. The public appreciation of the convenience and utility of the system is daily shown by the attention given to the stroke at noon. During nearly two years there has not been any interruption from the failure of the electro-magnetism.—*Langley in Account of the New City Hall, Pittsburgh.*

METEORITES IN INDIA.

The details have recently been received of a very remarkable fall of meteoric stones that took place on the 23d of September, 1873, in India. The largest pieces and the greatest number fell near the village of Kahirpur, in latitude 29° 56′ N., longitude 72° 12′ E. Five stones are mentioned as having fallen at this place, but others appear to have been obtained. At a number of other places stones also fell, and the whole district over which the fall seems to have spread has a length of sixteen miles in a southeast and northwest direction, and a breadth of about three miles. Many of the stones were found imbedded in the earth at a depth of about eighteen inches. The largest three weighed ten pounds, and were very irregular in shape, and all broken. As to the composition of these aerolites, it is of the usual steel-gray color and dense crystalline texture. The specific gravity of one of the pieces is given at 3.66. The appearance of the meteor was exceedingly brilliant, and its disappearance was followed, after an interval of about three and a half minutes, by a loud report, whose long reverberation died away like distant thunder.—*Journal of the Asiatic Society, Bengal,* 1874, 34.

ANCIENT EGYPTIAN ASTRONOMICAL OBSERVATIONS.

Renouf has communicated to the Society of Biblical Archæology the result of his study of the astronomical calendar which was discovered in 1829 by Champollion near Thebes, and which was supposed by him to present a table of the constellations and their influences for all the hours of each month in the year. This calendar, which has for fifty years formed the subject of numerous publications and speculations, is now interpreted in a very different manner by Renouf, who decides that it is a record of the position of the stars in the sky at certain times in the night. It is, in fact, a table of observations, and not of astronomical calculations. Once in the course of every fifteen nights the observer appears to have noted down at each successive hour the name of the particular star which was then actually upon the meridian. We do not know how he determined his meridian, what instrument he used, or by what contrivance he limited his observations, but he seems to have noted the passage of stars over seven different vertical lines. If the star were crossing the first line, beginning from the east, it was noted down as being "on the left shoulder;" if it were on the fourth line, which represented the meridian, it was put down as "in the middle;" if on the fifth line, it was observed as "on the right," and so on. The epoch at which these observations were made is calculated to have been within one century of the year B.C. 1500. From this calendar Renouf restores approximately the Egyptian names of a number of stars well known to us at the present time. Thus *Alpha Orionis* of modern astronomy corresponds with the Egyptian constellation known as the "Goose's Head;" the *Pleiades* were known to the Egyptians as "Chu;" *Coma Berenices* was called by them "The many stars," and so on.—*Transactions of the Society of Biblical Archæology*, III., 400.

B. TERRESTRIAL PHYSICS AND METEOROLOGY.

ON THE EVAPORATION OF WATER FROM HARD AND BROKEN SOILS.

In the course of an extended investigation by Schleh into the relation between water and plants, he shows that in respect to soils that are either matted down hard or well broken up, the former elevates by capillarity the water quicker and higher than the latter. If, then, layers of disintegrated soil are placed above masses of solid earth, the elevation of the water to the upper surface from the latter stratum is checked as soon as it comes to the loose soil. As the capillary power to elevate is diminished, so also is evaporation checked by the broken character of the soil; so that, as a general result of his investigation, a soil pressed hard together loses by far more water under the daily influence of the sun and the winds than a soil similarly circumstanced, but in which the upper surface is well broken up. The experiments of Schleh therefore give exact results, entirely confirmatory of the general practice of agriculturists.—19 *C*, VIII., 136.

ON THE CONDUCTIVITY OF VARIOUS KINDS OF SOIL FOR HEAT.

A. von Littrow, as the result of investigation into the conductivity for heat of various kinds of earth, concludes that the principal influence upon the conductivity of dry soils is exerted by their mechanical constitution, the conductivity being determined by the quality, as recognized by the microscope, of those portions of the soil that can be washed away. As the fineness of the grains of the soil increases the conductivity diminishes. Organic substances diminish the conductivity, and the influence of chemical constitution disappears in comparison with the mechanical features. Wet soils conduct the heat better than dry ones; in the pores of such soil water, which is a good conductor, has replaced the air, which is a poor conductor. With some exceptions, damp soils conduct heat even better than water does. Consequently in general the materials composing the soils must, of themselves, conduct heat better than water.

The curves expressing the conductivity of dry soils lie between the corresponding curves for water and the air, while the curves for wet soils lie, in general, on the other side of the curves for water; so that the conductivity of water is intermediate between that of wet and dry soils.—19 *C*, VIII., 145.

EARTHQUAKES AND MAGNETIC DISTURBANCES.

Professor Lamont, director of the observatory at Munich, says that many cases are known where magnetic disturbances coincide with earthquakes, and states that on April 18 he by chance saw the needle of the declination instrument receive a sudden jerk, the oscillations continuing for some time. After some days he received news that violent oscillations of the needle had been observed in Parma, and subsequent computations showed that the movement had begun at the same moment in Parma and in Munich; while, later still, reports were received of a violent earthquake occurring simultaneously in Greece.—12 *A*, X., 224.

PHYSICAL AND FAUNAL RESEMBLANCES BETWEEN THE LAKES OF GALILEE AND OF UTAH.

There is some resemblance between the physical conditions of the lakes of Galilee and of Utah. Both are in mountainous regions; and are fed by mountainous streams; both are connected by a river with a larger body of salt or brackish water. They are but few degrees apart in north latitude. About the year 1864 Dr. Tristram investigated the zoology of Palestine, and determined for the first time the true relationships of the animals enumerated by Moses. He discovered that the species alluded to as the "unicorn" is the wild buffalo of the East. He brought home a fine series of fishes of the Lake of Galilee, which have been determined by Dr. Gunther, of the British Museum. Seventeen species are included in the list, which enter seven families. There is an eel, a considerable number of chubs and minnows, a cat-fish, and four species of perch. No doubt the last named constitute the more highly valued edible fishes, and may be regarded as the especial object of pursuit of Andrew and Simon Peter, and of James and John. Perhaps it was one of these that our Lord had obtained when the apostles said, "A fire of coals burning, and fish laid thereon." In conformity with such ideas, Dr. Gunther named the species *Hemichromis sacra* and *Chromis andreæ* and *Chromis simonis*. The fourth is one with which the Jews must have been familiar before leaving Egypt, for it is the common perch of that country—*Chromis nilotica*. The fish from whose mouth Peter took a piece of money is said by mediæval writers to be the haddock, and the black spots behind the axillæ are asserted to be the marks of the toil-stained finger and thumb of Peter, miraculously preserved. As the haddock is a marine fish of the North Atlantic, and does not occur in fresh water, we are not surprised at not finding it in Dr. Gunther's list.

The fishes of Lake Utah have been collected by the naturalists of Lieutenant Wheeler's United States Survey, and number thirteen species. The number will, no doubt, be increased on fuller investigation. They are not nearly so varied in type as those of the Lake of Galilee, representing only four families. Three of these do not exist in the Palestine waters; but the fourth, the chub and minnow family (*Cyprinidæ*), is most largely represented in both. The others are of the sucker, whitefish, and salmon families, there being no perch, cat-fish, nor eels. There is but a single species of trout and whitefish each; but these go far toward supplying the economic deficiencies. The whitefish (*Coregonus williamsonii*) is a delightful table fish, and the most southern species of its family; while the trout (*Salmo virginalis*) is equally agreeable as food, and reaches a larger size. It has black spots on a silver ground, and a broad red band along the side, with red belly, red bars on the chin, red muzzle, etc. In the streams of the adjacent mountains a stouter species is found, the *Sâlmo pleuriticus*, which is similar in general color, but different in form, while the same crimson lateral band is seen in a sucker (*Catostomus discobolus*) which inhabits the tributaries of the Colorado River.

THE EARTHQUAKE OF BELLUNO.

The Royal Institute of Science in Venice, immediately after the news of the fearful earthquake that occurred on the 29th of June, 1873, in the province of Belluno, appointed a commission to make a thorough study of this subject.

From the report of this commission, consisting of Professors Pirona and Taramelli, it appears that the valley of Belluno is occupied by a tertiary formation, and that the earthquake shock was first felt at five minutes before five in the morning, lasting about fifteen seconds, and producing fearful destruction over the entire region. Two thirds of the city of Belluno was converted into a heap of dust. The movement of the earth-shock was from south to north, or, perhaps more correctly, from south-southeast to north-northwest. Many peculiar phenomena, such as the twisting of buildings, doors, walls, etc., took place, which have been fully explained by Mallet. Chasms were formed 200 feet long and one or two broad, but which subsequently closed. Lakes and brooks were altered, and springs dried up, while others were opened. In some springs there was noticed for twenty or thirty minutes a sulphurous taste, which, however, disappeared. No investigation appears to have been made into the location of the earthquake centre within the earth's surface.—7 *C*, X., 289.

THE EARTHQUAKE OF THE 22D OF OCTOBER, 1873.

Dr. Lasaulx has made a thorough study of the earthquake that occurred in Herzzogenrath on the 22d of October, 1873, and has found himself obliged to base his studies principally upon observations of the time at which the earthquake was felt. By means of a large number of such observations, he is able to draw curved lines connecting the points at which the shock was simultaneously felt, and thus incloses a central region directly over that spot within the earth whence the shock emanated. The velocity with which the wave was propagated along the surface of the earth was about ten miles per second. The depth of the centre was found, according to the method of Seebach, to be about six miles; while an independent computation by Professor Kortung gave a depth of three miles. It is evident, therefore, that the centre was in the solid part of the earth's crust, and the conclusion seems to be justified that the cause of the shock was the formation, or possibly the extension, of one of those cracks or faults that occur so frequently in that neighborhood, as revealed by the mining operations. A seismochronograph is described by Dr. Lasaulx, adapted to the determination of the exact moment of the shock, and it is highly desirable that such a simple instrument shall be extensively employed throughout the world in the investigation of these phenomena. Professor Abbe suggests that earthquakes are not beyond the reach of the Army Signal-office predictions.—7 *C*, X., 444.

RECENT VOLCANIC PHENOMENA IN ICELAND.

During the past winter attention was directed in Norway to the falling of dust from the atmosphere, which at first was supposed to be of meteoric origin; but Professor Kjerulf decided that it was more likely to have been disseminated from some active volcano. The precise source was unknown; but from the direction of the wind, and the known conditions, it was suspected that some volcano in Iceland was concerned. This surmise has been confirmed by the more recent advices from that country, which report a very remarkable series of volcanic phenomena, first commenced by earthquakes, then followed by an eruption accompanied by dust and ashes. On March 29, 1875, the fall of the ashes was so excessive that it covered the eastern country sides, Jökuldal especially, with a coat six inches in thickness, and all that day, although elsewhere it was bright and sunny, the people were in absolute "pitch" darkness. Fountains and rivulets were dammed by the ashes, and every mountain stream ran dark and muddy between banks covered with drifts of ashes. The farmers fled out of the ash-covered country with their cattle, in search of pastures not yet destroyed by the *scoriæ*, but with what chance of saving their live stock does not appear.

There is no calculating the extent of this calamity, nor its effect upon the habitable portions of Iceland, although from present appearances it threatens to be extremely widespread.—3 *A*, *May*, 22, 1875, 649.

THE FIGURE OF THE EARTH.

Mr. Hind, of Nova Scotia, calls attention to the fact that the equatorial bulge of the earth's surface may have been much larger in earlier geological epochs than at the present day, and that Captain Clarke's and General Schubert's investigations, according to which the earth's equator is an ellipse and not a circle, favor the idea that in these earlier epochs this ellipticity must have assumed the nature of a gradual change in the figure of the earth, in virtue of which a vast equatorial undulation has progressed with extreme slowness in an easterly and westerly direction.—12 *A*, X., 166.

UNDERGROUND TEMPERATURES.

The sixth report of the committee on underground temperatures states that they have made a very interesting series of observations in the great well of La Chapelle, at Paris. There was a tolerably regular increase of temperature at the average rate of one degree Fahr. for every ninety-four feet, except for the very last portion of the well, where a sudden increase appeared to take place, giving a rate of about one degree for every twenty-five feet. A very elaborate calculation has been made by the engineers in charge of the well, which has shown that a large portion of this sudden increase of temperature must be attributed to the heat generated by the operation of boring the well. The total weight of the tool employed by them is 3000 kilogrammes, and the quantity of work converted into heat at every fall of this great weight through a distance of fifteen inches is sufficient to raise the temperature of the lower portion to nearly 100° Fahr., which heat is retained at the bottom of the well for many days, owing to the feeble conducting power of the surrounding rocks.—*Report Brit. Assoc.*, 1873, 252.

"ICE CAVE" NEAR DOBSCHAU.

Dr. Joseph A. Krenner, of the National Museum of Buda-Pesth, gives an account of a visit to the famous ice cave near Dobschau, in the spring of 1873. It is located in the "Goellnitzer" valley, and is excavated in triassic limestone. From the entrance the trend of the cave is downward, a large mass of stratified ice, partly transparent, partly translucent, forming the floor of the higher and larger portions, while numerous stalactites and stalagmites of ice (the former hollow) ornament the ceiling and walls, forming at times exceedingly picturesque groups. Frozen waterfalls are found near the lower portions of the cave. The ice which serves as a floor is so compact and so smooth as to furnish excellent skating. The water that does not freeze runs off to the lower portions into a mass of débris, and appears as a spring on the side of the mountain containing the cave. A number of observations give the mean temperature of the cave at −0.86° C., while outside it was +3.53° C. Dr. Krenner states various reasons why the temperature can remain so low, and thus render possible the persistence of ice, as follows: The cave has only one very small entrance, from which it runs downward throughout its entire extent; the water that is not frozen has an opportunity to flow off without stagnating, or melting the ice; the position of the entrance is such that the sun never reaches it, therefore it must be comparatively cool; a current of cold air passes upward through the cave, tending to produce low temperature.

THE DEPOSITION OF FINE SEDIMENTS.

Dr. T. Sterry Hunt states, in reference to the question of the deposition of fine mud in the Mississippi, that the deposited matter requires from 10 to 14 days to subside; but that if sea-water or salt or sulphuric acid be added to the turbid water it becomes clear in from 12 to 18 hours. Thus is explained the rapid precipitation that occurs when the river water mixes with the salt waters of the Gulf of Mexico. The cohesion of water diminishes when it holds saline matter in solution, as was said by Guthrie and was verified by Dr. Hunt. He found that the addition of eight parts of chloride of calcium to 1000 parts of water reduces the size of drops to one ninth, and the precipitation of suspended clay is made very rapid when a strong solution of salt is employed.—12 *A*, X., 277.

SO-CALLED TIDES IN GREAT LAKES.

The question of the so-called tides in the greater lakes of North America is likely to receive some elucidation from the researches of Dr. Forel, of Lausanne, who has for several years been investigating what are known as the *seiches* of the Lake of Geneva, this term being applied locally to a certain oscillatory movement occasionally seen to occur on the surface of the lake. Forel agrees with previous observers in attributing the phenomenon to variations in the atmospheric pressure; and it is believed that it will be found to occur in all large bodies of water.

His investigations have led him to the conclusion that the *seiche* is an oscillatory undulation, having a true rhythm, and that the phenomenon is not occasional, but constant, though varying in degree. The duration of a *seiche* is a function of the length and depth of the section of the lake along which it oscillates; this duration increases directly with the length and inversely with the depth of the lake. The instrument he has devised for the investigation of the phenomenon is a "tide measurer."—12 *A*, *June* 17, 1875, 134.

SECULAR CHANGES IN THE LEVEL OF THE OCEAN.

Professor Schmick has called attention to the fact that his theory of the existence of regular periodical changes of the level of the sea, and especially of a secular movement from the northern to the southern hemisphere, is apparently supported by the conclusion of the astronomer Nyren. The latter has shown that the latitudes of all well-determined observatories in the northern hemisphere have slightly diminished since accurate observations began. This phenomenon is, according to Schmick, easily explained by the hypothesis that the water of the Southern Ocean is now about perhaps two feet deeper than it was a hundred years ago, which hypothesis accords precisely with the conclusion to which he was led by the entirely different course of reasoning published by him some years ago in his works on floods, etc.—*Gaea*, XI., 29.

TIDES OF THE EASTERN ALEUTIANS AND THE NORTH PACIFIC.

In the appendix to the United States Coast Survey Report for 1872, now in press, is a report by Mr. W. H. Dall on the tides, currents, and meteorology of the Eastern Aleutian region and the Northeast Pacific, accompanied by explanatory diagrams. Mr. Dall's observations on the oceanic currents, which are here tabulated and discussed up to the date of the report, are of special interest, as being the first series undertaken with a direct view to the solution of the problems in question, and result in the proof of there being a reflexed northerly arm of the great easterly North Pacific current, de-nominated by him the Alaska current, which had previously been surmised from isolated observations and theoretical considerations. Mr. Dall has been able to determine the rate and dimensions of several portions of this current, and the maximum, minimum, and mean annual temperature. The existence of definite oceanic currents in the eastern half of Behring's Sea is shown to be very doubtful. Some important generalizations on the relations of the Pacific and Behring's Sea tides to each other are made, and the peculiarities of the compound tides of this region are graphically indicated by diagrams in a new method, original with the author, and possessing some interest for those studying these problems. The report is accompanied by numerous hydrographic memoranda, and tables of meteorological, current, and tidal observations.

ORIGIN OF OCEAN CURRENTS.

Mühry, in a paper on the origin of ocean currents, states that a difference of temperature in the equatorial and polar regions of the ocean is not sufficiently powerful alone to bring about the great hydrodynamic effect attributed to it, viz., the existing phenomena of latitudinal circulation. This latter is largely a result of the rotation of the earth, although the thermal circulation is frequently of great importance. He finds that the latitudinal oceanic circulation is to be considered as a duplicate one, that is, resulting from two causes working in the same direction, the one being the general diminution of gravitation toward the equator, and the other the general elevation of temperature, with its consequent expansion of the sea-water, each circulation existing by itself, independently of the others. The difference of density due to a difference in the saltness of water, according to Mühry, has no influence in the formation of currents.—*Zeitschrift für Meteorologie*, IX., 282.

THE CIRCULATION OF OCEAN CURRENTS.

Dr. Carpenter calls attention to the researches on ocean currents and deep-sea temperatures of Lenz, who accompanied the Russian exploring expedition of Kotzebue in 1823–26, and made a large number of observations of temperatures of the ocean water with thermometers whose indications were carefully corrected for the influence of the pressure of the water. Lenz deduced the important conclusion that there is at and under the equator a belt of water cooler than the water to the north and south of it, the existence of which is explained on the principle that there must be a flow of warm surface water from the equatorial regions toward either pole, and which must be accompanied by a corresponding flow toward the equator in the lower regions of the ocean, so that at the equator itself, where the two deep-sea currents meet, cool water rises to the surface. This principle has been independently propounded by Dr. Carpenter to explain the cold band between the Gulf Stream and the United States coast, and justifies him in the statement that his own researches during the past ten years have but afforded a confirmation and elaboration of Lenz's doctrine of oceanic circulation.—12 *A*, X., 170.

NEW GENERALIZATION IN OCEAN PHYSICS.

A new generalization of much importance in reference to ocean physics has lately been derived from the observations of the *Challenger* in the Malay Archipelago during her recent passage from Cape York to Hong-Kong. The seas visited, we are told, consist of a series of sunken lakes or basins, each surrounded and cut off from the neighboring seas by a shallower rim or border. There is a general oceanic circulation down to a depth equal to that of the border, and the temperature gradually decreases from the surface to this level. The entire mass below, however, having no communication with the outer water, and consequently no circulation, remains at nearly the same temperature as that flowing over the floor of the rim; or, in other words, the water coming along the floor of the ocean from the antarctic seas, which is found in all the deep open channels, can not obtain admission through or over the rim.

On this account the bottom temperature depends entirely upon the altitude of the encircling rim. Thus, in Torres Strait, with a depth of 2450 fathoms, and a rim reaching within 1300 fathoms of the surface, the body of water below that depth has a steady temperature of 35°. The Sulu Sea, which is 2550 fathoms deep, with a rim reaching within 400 fathoms of the surface, has a temperature to its bottom as high as 50°. The Molucca Passage, however, is open to the depth of 1200 fathoms, and the China Sea to that of 1500 fathoms.—12 *A*, *Dec.* 31, 1874, 174.

INFLUENCE OF WINDS UPON THE TIDES.

In the appendix to the recent volume of the report of the United States Coast Survey, Mr. Ferrel presents a revision of his discussion of the tides of Boston Harbor, in which, among other matters, he investigates the effect of winds and barometric pressure on the height of the tides. After comparing the actual observations with the ordinary formula for computing the heights of the tides, certain residuals remain, which may possibly be in part explained as due to the influence of the winds and the barometer. He shows that this influence varies very much in different parts of the world. Thus, at Boston, a rise of an inch in the barometer is followed by a fall of seven and one-third inches of water. At Brest, however, for the same change in pressure, the change in the water is fourteen and one-ninth inches, and at Liverpool eleven and one-tenth inches, while at London it is only seven inches, being even less than the value obtained for Boston. The direct effect of atmospheric pressure is probably to a large extent inextricably complicated with the influence of the winds. Mr. Ferrel suggests as an explanation that when the barometer is rising we usually have clearing weather on the New England coast, with westerly winds, which tend to lower the sea level; they consequently more than counteract the direct effects of inertia and friction. When the barometer is falling there are usually east winds, or, at least, an absence of west winds, and the sea level at this time is a little above the mean level. Very strong winds change the sea level in Boston Harbor a foot or more, ten such cases occurring in the course of one year.—*Report of the U. S. Coast Survey*, 1871, 94.

THE CHALLENGER OBSERVATIONS ON THE DEEP-SEA BOTTOM.

Professor Huxley, in a recent lecture at the Royal Institution upon the work of the *Challenger* expedition and its bearing upon geological problems, sums up the general results, in regard to the composition of the ocean bed, by showing that from the researches of Sabine, Ross, Penny, Ehrenberg, Bailey, and others, it was then known that from deposits, chiefly of the siliceous cases of plants of the lowest order, the diatomaceæ, a "cap" of siliceous sand was being formed at the northern, and another at the southern pole. It was also proved that the grand areas of the general sea-bottom of the Atlantic and Pacific oceans were similarly constituted of a girdle of calcareous mud, of indefinite depth, formed by a similar vein of discarded calcareous shells of animals of low organization—the foraminifera. Now this white calcareous matter of the foraminifera shells has been shown by the *Challenger* researches to be replaced, in certain deep oceanic valleys between Tristan d'Acunha and Kerguelen's Island, and elsewhere, by a very fine red clay. In certain geological deposits, of greater or less antiquity, beds of glauconite, or green siliceous sand, exist, which are composed entirely of the casts of ancient foraminifera formed of a green material, which is a compound of silicate of iron and alumina. The chemist of the *Challenger* having found that, from the decomposition by weak acids of the calcareous shells dredged up from the 18,000-feet depths, there is a residuum of one or two per cent. of red marl, exactly like that dredged up from the 18,000-feet depths of the valleys referred to, the conclusion is arrived at that the red mud is the accumulation of this small percentage of clayey matter, resulting from the wholesale decomposition of the calcareous polythalamous shells. The novelty of the *Challenger* discovery consists, therefore, in the fact that clay deposits can also be assigned, like siliceous and calcareous deposits, to the resultant débris of organisms living at the surface of the sea. Supposing, therefore, that the whole globe were immersed under an entire envelope of water, deposits of all the materials of our stratified geological rocks could be going on without the slightest assistance from the degradation and wearing away of any actual land surface at all; and these deposits, subjected in the ordinary natural course of events to ordinary processes and actions, could be modified into gneiss, schists, slate, limestone, and every variety of geologic rocks.—3 *A*, *Jan.* 6, 1875, 171.

INFLUENCE OF FORESTS ON CLIMATE.

Claré, in the *Revue des Deux Mondes*, takes strong ground as to the exercise by forests of a very decided influence upon climate. In his article he remarks that forests have a chemical, physical, physiological, and mechanical action on the climate of a country. In regard to the physical action, while the foliage of woods allows much less rain-water to reach the ground than in unwooded land, this is more than compensated by the difference of evaporation in the two cases, that of the open fields being nearly five times as great as that of the woods. The melting of snow, too, is retarded by forests, thus causing a more gradual outflow of the water. Again, forests are obstacles to atmospheric movements. An air current meeting a wood is compressed and forced upward, so that it yields part of its moisture in the form of rain. Forests also protect crops against the winds; and it is an established fact that thunder-storms are less frequent and violent in wooded regions than in open countries, as the trees draw from the atmosphere the electricity it contains, which accumulates on regions that are bare. Forests, too, have a decisive action as regards the formation of hail, hailstorms occurring but rarely in a wooded region. A case has lately been noted where a violent hailstorm on approaching and crossing a forest ceased to produce hail, but resumed its formation on passing to the unwooded country beyond.—18 *A, June* 11, 324.

NOTE ON THE VERTICAL DISTRIBUTION OF TEMPERATURE ON THE OCEAN.

Mr. Buchanan, chemist on board of the *Challenger*, writes that the effect of the changing seasons on the temperature of the sea-water seems to him not to have received sufficient attention. During the whole period of the heating of the water it has, from its increasing temperature, been steadily becoming lighter, so that the communication of heat to the water below by convection has been entirely suspended. It has, also, by evaporation, become denser than it was before at the same temperature. During the approach of winter, the superficial water having cooled, sinks through the warmer water below it, until it reaches the stratum having the same temperature as itself. Nor does it stop there, but continues to sink, owing to its density, carrying its temperature with it to the lower colder layers. The result is that we have during the winter a heating effect going on in the lower regions, and during the summer a cooling effect; so that the greater the yearly range of atmospheric temperature, the greater the depth in the ocean to which its effect will be felt. He thus explains the presence of the large body of comparatively warm water in the North Atlantic, the existence of which has been usually ascribed to an assumed back-water of the Gulf Stream. This warm water is, in fact, due to no such extraneous cause, but is the actual effect of the conditions of the climate at the surface, which effects become apparent, because the water is free from the influence of oceanic currents, and exposed to the effect of climate alone.—*Proceedings of the Royal Society*, 1875, p. 123.

NAUTICAL METEOROLOGY.

Nautical meteorology has for its object the study of both atmosphere and ocean in their relations to navigation, and the utilization of our knowledge of the winds and currents, the laws of tempests, etc., in order to accomplish the shortest possible voyages between given points. The foundation of this application of scientific study to the wants of navigation was laid by Maury, and a recent work by Ploix and Caspari seems to embody many of the recent improvements that have been made. This work is intended as a guide to the mariner in the use that he can make of the charts published by meteorologists. After giving a general descriptive account of interesting phenomena, instruments, methods of observation, and the general climatological features, the volume gives a *résumé* of the oceanic routes recommended for the different months of the year throughout the navigated oceans. For instance, it insists especially upon the importance of attending to the point where the ship crosses the equator in passing from one hemisphere into the other. Thus, in order to go from Europe to either the Cape of Good Hope or to Cape Horn, we should cross the equator at the same point; but, varying with the seasons, we should pass either near the African or near the Brazilian coasts, but never in the intermediate region where the navigator is exposed to persistent calms. Another interesting point is the navigation in high southern latitudes, where we meet almost constantly west winds. Thus, in order to go to Australia, we sail from Europe to the south of the Cape of Good Hope, but in order to return it is preferable to sail from Australia eastward past Cape Horn.—*Bulletin Hebdomadaire*, XVI., 28.

ON THE THEORY OF TORNADOES AND WATERSPOUTS.

In a general investigation into the phenomena of the cyclonic movements of the atmosphere, Cousté states that, starting from the general principle that there exists at the centre of the cyclone a column of ascending gyrating air, he deduces logically the following conclusions: First, the whole column must rotate about its geometrical axis, in the opposite direction to the gyration. Secondly, there must be a vertical oscillating movement by which the column alternately rises above and descends to the ground, carrying devastation before it. Thirdly, there must be a movement of translation, which is accomplished, as shown by observation, with a rapidity varying between twenty and seventy miles per hour. These three movements are derived from the centripetal forces developed by the gyration which give rise to lateral streams of air, which he calls radiating filaments, in opposition to those interior filaments which gyrate within the helix, and which he calls helicoidal filaments. These radiating filaments of air form a nappe which incloses the whole convex surface of the tornado, and they constitute the wall of the column, which wall, for a given state of dynamic equilibrium, is as solid as if it were a solid matter of sheet iron, for example, yet is permeable and indefinitely extensible according to the conditions of its dynamical equilibrium. These filaments are directed from below upward, following the tangent to the helix farthest from the axis, producing reactions similar to those in turbine wheels. Cousté has also determined the character of the movement along the surface of the earth; this is, in general, of a spiral nature, at least for waterspouts properly so called, which appear as truncated columns, suspended from a cloud. But for those tornadoes whose trajectory is nearly rectilinear, and for the cyclones and hurricanes whose birth takes place upon the ocean the trajectory takes the form of a parabola, whose summit is always near the side of some large continent. These remarkable peculiarities he explains by the following principles, which he has deduced from his theory: First, if the angular velocity of gyration increases or diminishes—that is to say, if the energy of the meteor increases or diminishes—the curvature of the trajectory will rapidly increase or diminish. Second, the energy of the meteor is greater in proportion as the air which it draws in is dryer, or has a low relative humidity.

In reference to the rigidity of the column of the waterspout, Cousté says that the equilibrium between the reacting forces due to the radiating filaments exists even when the various diameters of the waterspout are made unequal by the pressure of the wind. The normal components of the movement of the wind have the effect substantially of pressing the helicoidal filaments together normally to the surface, thus concurring to maintain the rigidity of the column, to which the gyratory movement contributes. This we can easily comprehend if we compare the column to the gyroscope of Foucault; for the column of the waterspout can be likened to a series of gyroscopes having a common vertical axis, the revolving disks being formed by parallel horizontal sections of the column. In the case of the tornado the disks are gaseous, it is true, but the gas is kept in its place by the normal components of the forces; and if they have but little mass, they are, on the other hand, actuated by very rapid velocity of rotation.

Theoretically, a waterspout is a collection of parallel whirling tubular masses; a complete illustration of this is, however, very rare in nature, though such have been figured by Mouchez and others.—*Nouv. Meteorologiques*, 1875, p. 61, 81.

TREATISE ON METEOROLOGY BY MOHN.

An important treatise on meteorology has lately been published by Mohn, the distinguished chief of the Norwegian Weather Bureau. It constitutes an original German edition, with many improvements, of the work published two years ago in Norwegian, under the auspices of the Society for the Dissemination of Useful Knowledge. As was to be expected, Mohn has especially developed in this work the ideas that he has for some years defended with reference to the influence of moisture in the air upon the movements of storm areas. His whole work, in fact, corresponds to the present condition of meteorology, except, possibly, that the attempt to provide a purely popular explanation of the mechanical laws controlling the movements of the atmosphere is somewhat unsatisfactory to the professional student.

APPLICATION OF AMSLER'S PLANIMETER TO METEOROLOGICAL CALCULATIONS.

Mr. Scott, of the Meteorological Office in London, reports that perfect success has attended the adoption of Amsler's planimeter in the calculation of the average daily temperatures. The instrument was applied directly to the photographic sheets of the self-recording instruments, and was also applied to the reduced copies of these sheets, as published in the quarterly weather reports, and the results thus obtained check each other satisfactorily.

RAINFALL AND SOLAR SPOTS.

In the monthly notices of the Meteorological Society of Mauritius, Mr. Meldrum, of that island, concludes that, whether we take the annual rainfall for the largest possible portion of the globe for short periods, or for a small portion of the globe for a longer period, we arrive at the same result: viz., an increase of rain at or near the epochs of maximum sun spots, and a decrease of rain at or near the epochs of minimum sun spots. The exceptions to this law are few and trifling, and disappear from the results as the inquiry is made to cover more extended portions of the earth's surface and a longer interval of time.—12 *A*, X., 418.

THE DRY SEASON OF BRAZIL.

As an illustration of the extreme dryness of the soil during the dry season in Brazil, it is stated that, in June, all vegetation ceases, the seeds being then ripe or nearly so. In July the leaves begin to turn yellow and fall off; in August an extent of many thousands of square leagues presents the aspect of a European winter, but without snow, the trees being completely stripped of their leaves; the plants that have grown in abundance in the wilderness drying up, and serving as a kind of hay for the sustenance of numerous heads of cattle. This is the period most favorable for the preparation of the coffee that grows upon the mountains. The beans are picked and laid on the ground, which gives forth no moisture, but on the contrary absorbs it, and being surrounded by an atmosphere possessing the same desiccating properties, the coffee dries rapidly without becoming mouldy.—*The Empire of Brazil*, p. 23.

REPORT OF THE SIGNAL SERVICE OBSERVER ON PIKE'S PEAK.

The Signal Service observer on the summit of Pike's Peak reports that the local storms there experienced originate over the parks to the westward, on hot afternoons. On one occasion he was favored with an excellent view of the interior structure of the clouds of a tornado, when he observed that while the cloud-bearing currents of air float toward the centre they had a decided downward movement, but that masses of smoke-like vapor rapidly ascended through the interior funnel.

THE FREQUENCY OF STORMS.

Köppen has made an investigation of the frequency with which barometric minima occur in Northwestern Russia. He finds that during the years 1872 and 1873 107 cyclones occurred, lasting altogether 393 days, the mean duration of each one of these being about three and seven-tenths days. According to a table given by him, if a barometric depression is just leaving the observer, it is probable that within one or two days a second cyclone will occur. If, on the other hand, many days have elapsed since the passage of a depression, and uniform and high pressure has prevailed, then the probability that a new depression will arrive within twenty-four hours is diminished by one half.—19 *C*, VIII., 86.

THE PASSAGE OF STORMS TO EUROPE FROM AMERICA.

The great storm that passed over the coast of Germany on the 22d of November, 1873, has been investigated by Prestel, who concludes that it was identical with the storm that left the United States on the 18th day of the same month, which was at the time distinguished as a severe disturbance. In his remarks upon this subject, Mr. Prestel possibly goes too far in attempting to show that certain storms recur at certain epochs of the moon, but he is nevertheless probably nearly correct in saying that many attempts to trace lunar and other periods in the changes of the weather have, as yet, had only a negative result, because we have considered only observations referring to a single place. It may, in fact, be stated that the currents of the atmosphere never follow precisely the same routes, nor have precisely the same effects; consequently individual places on the earth's surface are at one time within, at another time beyond, their influence, and the weather at one point shows nothing of the periodicity that may possibly regulate the movement of the current itself. Under these circumstances, the observed local readings of the barometer, temperature, rainfall, etc., can not be expected to follow any such laws of periodicity as may possibly be followed by the atmosphere as a whole. The periodicity of atmospheric phenomena can, actually, only be properly investigated when we combine the geographical details with the element of time. Following this idea, Prestel feels justified in the conclusion that certain storms which have visited the earth have passed over nearly the same paths at their successive apparitions, which latter always occur when the moon returns to about the same position with reference to the earth. As this can only happen every nineteen years, it follows that the storms of 1873 are to some extent a repetition of those of 1854.—*Zeitschrift für Meteorologie*, IX., 224.

CAUSE OF THE WARM CLIMATE OF THE WEST COAST OF NORWAY.

Professor Karsten, in an address delivered before the Society of German Scientists and Physicians, stated that the comparatively mild temperature which characterizes the west coast of Norway is not, as has been hitherto considered, the effect of the Gulf Stream, but of a warm current of water that leaves the Baltic when the cold weather sets in.—13 *A*, *November* 21, 1874, 560.

CONNECTION BETWEEN THE SEASONS AND HUMAN MORTALITY.

Messrs. Mitchell and Buchan have made a very thorough study of the influence of the seasons on human mortality, basing their investigations on thirty years of observations at London. The greatest mortality is above the average from November to April; falls to a minimum at the end of May; then rises to a maximum on the third week of July, continuing there until the second week of August, and falling thence to a secondary minimum in October. Deducting the summer excess, which is due to one section of the population (namely, infants) and to one class of diseases (namely, bowel complaints), there remains an excess in the cold and a deficiency in the warm months, which is due to the diseases of the organs of respiration.—12 *A*, X., 210.

THE DISTRIBUTION OF THUNDER-STORMS.

Hildebrand has investigated the distribution of thunder-storms in Sweden for the year 1871, basing his study upon the observations of about two hundred and fifty stations. The number of days on which thunder was observed varied between one, two, and three in March, April, October, and November, to twenty-seven in July. Thunder-storms are found to be less frequent, not only in the cold months, but also as we proceed northwest. With regard to the daily distribution of these storms, he shows that the greatest number have occurred between 4 and 6 P.M.; the least have occurred between 10 P.M. and 6 A.M. The greater number of thunder-storms come from the northwest; whence also come the clouds and wind. Le Verrier has long since shown that in France the thunder-storms occur on the advancing side of the general atmospheric disturbances, and that they follow the movements of the cyclones; but that, on the other hand, many thunder-storms are purely local. Mohn has likewise studied the subject in Norway, and comes to conclusions quite similar to those of Le Verrier. Mohn has furthermore shown that the origin of the thunder-storm is to be found in the ascent of warm, moist currents of air. These latter, however, also develop in connection with volcanic eruptions accompanied by whirlwinds, and also when the lowest strata of air are overheated in the hottest hours of the day. He therefore classifies the thunder-storms as whirlwind thunder-storms and heat thunder-storms. The former originate on the advancing side of cyclonic storms, and follow their movements over entire countries. The latter class originate on the hot summer afternoons, and are to be considered as purely local phenomena. If, however, we combine the observations of Mohn and Le Verrier with those of Breitenlohner, it will appear difficult to make so sharp a distinction as Mohn has attempted, since both causes are acting at the same time; so that extended and regularly advancing thunder-storms co-exist with merely local ones. The latter are, indeed, generally sporadic, and especially frequent in favorable localities, such as mountains and forests. A passing cyclonic storm is always favorable to the formation of local thunder-storms. The peculiarly favorable conditions that prevail at certain localities are shown in a very interesting way in the work of Prettner on the climate of Carinthia. — *Vierteljahres-Revue der Naturwissenschaften*, II., II., 190.

A NEW BAROMETER OF LARGE SCALE.

The great desirability of being able to observe the slightest changes in atmospheric pressure has led to the production of many more or less unsatisfactory barometers, of which in general it may be remarked that, although they do really afford us a highly magnified scale of movement, yet the moving parts are themselves so weighty that the sluggish behavior of the instrument entirely neutralizes the advantage which was sought, so that the slight momentary changes in atmospheric pressure still pass by unperceived. To meet these difficulties, Mr. Hirn, one of the most eminent French philosophers, has described an instrument which he calls the Megabarometer: his apparatus consists of three vertical glass tubes, closed at their ends, and connecting with a horizontal tube by means of iron sockets. The middle tube, filled with mercury up to half an inch of its top, is a true barometer. Its neighboring tube on the one side has about four millimeters' internal diameter, while the other tube has one millimeter diameter, but is soldered at its top to a closed bulb of about four centimeters' internal diameter. The lower half of this bulb is filled with mercury, the upper half with alcohol. The first of the three tubes thus constitutes a barometer composed of two liquids, and the variation of level in the two open tubes on the right and the left hand is very nearly in an inverse ratio to the densities of the liquids; so that a change of one inch in the height of the mercury brings about a change of seventeen inches in the alcohol tube.—*Nouvelles Meteorologiques*, p. 34.

MIRAGE.

In some remarks on the phenomena of mirage, Professor Everett states that when a ray of light is passed through a portion of air which is not equally dense on all sides of the ray, it is deflected toward the side on which the density is greatest, the sharpness of the curvature being proportional to the rates at which the density varies. If the air is stratified horizontally, it follows that a ray traveling nearly horizontally will be bent the most, and it is by such rays that we see the images which constitute mirage. In the average state of the atmosphere the curvature of horizontal rays is about one fifth or one sixth of the curvature of the earth's surface, being greater in cold than in warm weather, and greater with high than with low barometer. The curvature, however, depends principally upon the rate at which the temperature changes with the height. The average rate is one degree for 300 feet. If the rate were one degree for fifty-three feet, the horizontal rays of light would be straight lines. A more rapid rate than this will render the air above denser than that below, and cause rays to bend up instead of down. This condition of affairs may exist for a time, although it is a condition of unstable equilibrium, and must eventually be broken up by the inflow from the surrounding regions of cold air. An increase of temperature upward at the rate of about one degree in sixteen feet will make the curvature of horizontal rays equal to that of the earth, so that they may encircle the globe. Any such downward bending of rays of light increases the range of our vision, enabling us to see around the horizon, which otherwise limits the view, thus bringing distant objects in sight, and rendering nearer objects more distinctly visible, but without in any way inverting them.—12 *A*, XI., 151.

THE NEW SELF-RECORDING BAROMETER.

A self-recording barometer has recently been made by Mr. Redier, which seems to have many excellent points, and to be enthusiastically received in France. In a communication to the Meteorological Society of Paris, he states that his instrument consists of an ordinary syphon barometer carrying a very light ivory float, upon which is fixed a vertical steel wire terminating in a point. A horizontal needle rests upon this point, its other extremity is in connection with a double series of clock-work, the wheels of which move either forward or backward, according as the ivory float rises or falls. The movements of the clock-work are followed by a pencil which draws a curve upon a revolving cylinder. In a very similar instrument devised by Professor G. W. Hough, of Albany, and highly prized by American meteorologists, the connection between the horizontal lever and the wheel-work is an electric one, and subject therefore to all the uncertainties of the electrical batteries and connections. In Redier's barometer no electricity is employed, the entire apparatus depending only upon gravity and atmospheric pressure, and its working is evidently perfectly regular and reliable. An aneroid barometer may be made to record its indications in the same manner as the mercurial, and such instruments have, we understand, already been constructed under Mr. Redier's directions. Mr. Silberman has suggested a method by which a similar automatic system of registration could be applied to the indications of the magnetic needle.—*Nouvelles Meteorologiques*, 1875, p. 16.

CURRENTS OF AIR WITHIN CYCLONES AND WATERSPOUTS.

In a memoir on cyclones and waterspouts, Mouchez publishes some observations made by him while upon the ocean, and which, if correct, are quite important. According to him, at or near the surface of the ground the movement of air in the cyclone is always from below upward, while in whirlwinds the movement is, on the contrary, from above downward. In the former case the winds are winds of aspiration; in the latter case the wind descends from the cloud in the form of a bag or tube, which terminates in a point. He believes that waterspouts have no relation whatever to cyclones, having an opposite appearance and cause. In this opinion Renou also concurs.—*Nouvelles Meteorologiques*, 1874.

THE PROGRESSIVE MOVEMENT OF AREAS OF COLD AIR.

Dove has attempted to deduce, from the five-day means of temperature for European stations, some general views as to the progress of days of remarkable cold, and finds that in the months of January and February of the years 1855, 1856, 1870, and 1871, numerous cases occurred to show, almost uniformly, that the "cold terms" move westward over Europe;

a result that may, perhaps, be considered as entirely in agreement with the deductions of Buchan, based upon the barometric charts prepared by him.—*Monatsbericht Berlin Acad.*, *Feb.*, 1874, 118.

A VERY DELICATE BAROMETER.

An ingenious device has been constructed by Mendelef, which shows the slightest variations of pressure by means of a small U-shaped tube containing petroleum oil. One end of this tube is closed, and contains a certain volume of dry air maintained at a constant temperature, while the other end is open to the air. The instrument being accurately adjusted by means of a mercurial plunger connected with the bottom of the U-shaped tube, so that the petroleum is exactly on a level in the two branches of the tube, it is found to be so extremely sensitive that the slightest variation of atmospheric pressure is shown by the alteration of the level, and the amount of this alteration can be measured with the greatest precision.—12 *A*, XI., 55.

THE PENETRATION OF COLD INTO THE EARTH.

From observations on the temperature of the surface of the earth which have been made regularly at the Botanical Gardens at Paris, by the Messrs. Becquerel, by means of the electric thermometer invented by them, some interesting conclusions have been deduced. Their observations have been extended to the depth of one hundred and seventeen feet; but most attention has been paid to that portion of the earth nearer the surface. With reference to the penetration of cold into soils of similar character, but one of which is bare and the other covered with grass, while both are covered with snow, the observations have shown that when the temperature of the air sinks from zero to —12° Centigrade, the temperature of the earth at the depth of twenty inches never sank to zero under the grass-covered earth, while it sank at the same depth to —5° under the bare surface. From these observations Becquerel makes the practical suggestion that if in a sandy soil we desire to cultivate plants whose roots suffer from frost, we must cover the soil with grass-sod; and, for similar reasons, if we desire to preserve vegetables or other products during the winter under the soil, and secure them from frost, we should in this case also cover the soil with grass.—19 *C*, XIV., 135.

AQUEOUS VAPOR IN THE ATMOSPHERE.

The *Academy* sums up the conclusions of Dr. Hildebrandson, of Upsala, in regard to aqueous vapor in the atmosphere, as follows: 1. The permanent gases in the atmosphere do not form independent atmospheres, but have effected a complete mutual interpenetration; as all experiments show that the constitution of the air is the same at all heights. 2. The incessant evaporation and condensation which are in progress render impossible the existence of an independent vapor atmosphere, or of a homogeneous mixture of the vapor with the permanent gases, and must cause the vapor to diminish rapidly with height. 3. It is not allowable to subtract the vapor pressure from the barometer reading to obtain the pressure of dry air.—13 *A*, *Feb.* 6, 1875, 145.

THE NEW ANEMOSCOPE.

Michelle describes an ingenious anemoscope in which three arrows are used, of which the upper one indicates the direction of the wind at each moment. The second indicates the extreme wind on the right, and the third indicates the extreme wind on the left hand. Thus, when one looks at the wind vane, we see not only the wind that now prevails, but the extreme winds on either side that have prevailed since the preceding observation.—*Bulletin Hebdomadaire*, XVI., 12.

PERIODICITY OF RAINFALL.

Governor Rawson, of the island of Barbadoes, whose remarkable studies upon the rainfall of that island have been already noticed, states that it is an error to suppose, as Mr. Meldrum does, that the observed rainfall in Barbadoes in any way really supports Mr. Meldrum's theory that there is a sun-spot period in these meteorological phenomena. He, however, very philosophically adds that, if the conclusions drawn from a wide area and very long periods of observation do support that theory, then the opposite results obtained in Barbadoes, although that island is most favorably situated for these observations, only show that no particular locality can draw a safe inference as to the manner in which the presence or absence of sun spots is likely to affect it.

But looking more deeply into the matter, Governor Rawson very justly adds that if there has been more rain in certain quarters of the globe in certain years, there must have been in other quarters during those same years greater evaporation, whence it results that the same solar phenomena produce in one portion of the world opposite effects to those produced elsewhere.—12 *A*, X., 264.

MARITIME CONFERENCE IN LONDON.

At the recent Maritime Conference in London the resolutions adopted by the meeting embraced the following subjects. It was resolved that there should be but one form of meteorological register for naval and merchant services, and that so far as possible a uniformity in methods and hours should be observed. Ocean currents and magnetic variations were recommended for observation. The upper and lower clouds are to be recorded in separate columns. The precise patterns of instruments were not specified, the only requirement being that those used should satisfy certain tests, and that they should be carefully compared with standard instruments. It is considered that the general influence of the Conference was decidedly in favor of united action on the part of the merchant service and the navies of the world. Particular stress was not laid upon the conducting of special investigations by sea-captains, as such can be most economically performed at the central meteorological stations and by government naval vessels.—12 *A*, X., 431.

THE TEMPERATURE OF STORMY WINDS.

Dr. Fritsch, of Vienna, communicates to the *Annual* of the Vienna Meteorological Institute some observations on the temperature of the storm-winds at Salzburg. He states that, since 1864, he has every summer resided in Salzburg without noticing the high temperatures of the southeast storm-winds; but that since he has resided there constantly during the past few years, this has been forcibly brought to his attention, as also the great dryness which accompanies these winds. From the records made at 7 A.M., and 2 and 9 P.M., from 1863 to 1869, he has selected the stormy winds, and finds that both the southeast and northwest storms experienced at that place are much modified by the influence of the Alps. The southeast, or föhn, wind has, at all seasons and at all points, a notably high temperature, the exception only being in the three summer months, in which the föhn decidedly depresses the temperature. In the winter and summer the temperatures of the southeast and northwest storms are nearly the same, but in the spring and fall the southeast are decidedly warmer than the northwest storms. In the high southeast winds the air is clear and dry, but in the northwest cloudy and moist.

ON ATMOSPHERIC PRESSURE, WINDS AND RAIN.

A recent supplementary volume of Dr. Petermann's geographical notes gives us a comprehensive memoir on our present knowledge of the atmospheric circulation by Dr. A. Wojeikof, which is accompanied with highly interesting and valuable charts; the last of the charts gives us a new view of the distribution of rain over the earth, in that it distinguishes between the areas of summer and winter rains, besides giving us the results of the most recent investigations as to the general distribution of the rain-belts of the earth. In general, Dr. Wojeikof finds that between the poles and 40° of latitude the rainfall is liable to occur at all seasons of the year, the variations being seasonal in their nature. Thus Siberia and British America receive most of their rains in the summer time; Great Britain, Norway, France, and Portugal receive their rains in the fall. Between these polar regions and the rainless zone of the trade-winds Wojeikof introduces belts of sub-tropical rains, which are, he thinks, essentially oceanic, while the polar rain-belts are essentially continental. In considering the distribution of rain in Siberia, he states a law which, verified by independent observations, is a remarkable confirmation of a theoretical deduction due to Mr. Ferrell. According to Dr. Wojeikof, the atmospheric pressure in winter in the higher latitudes is lower over those seas that have no connected ice-fields. According to Mr. Ferrell, the pressure in the polar regions of the earth is lower in proportion as we diminish the frictional and other resistances offered by the earth to the movement of the air. If, therefore, the resistance offered by fields of ice is sensibly greater than those offered by the open sea, or small ice-floes, then Professor Ferrell's proposition explains at once Dr. Wojeikof's generalization.—*Petermann's Mittheil.*, *Ergänzungsh.*, No. 38.

THE IMPORTANCE OF METEOROLOGY.

The annual report of the Radcliffe Observatory, delivered at Oxford, June 29, states that the principal labors at that institution continue, as formerly, to be given to the transit circle and the heliometer, and that the meteorological observations made at that observatory are reduced much more elaborately than is done at the greater number of astronomical observatories, and are presented to the public in the most scientific shape that they admit of. "I am also of the opinion that they are worthy of the labor which is bestowed upon them, and I differ in opinion from some eminent authors as to the rank which meteorology already occupies among the physical sciences. At all events, I think a similar system of reduction should be employed at other observatories."

SECULAR CHANGES OF CLIMATE.

"The Indications of Spring" is the title of a work communicated to the Royal Society, in 1789, by Mr. Robert Marsham. These indications were based upon observations, commencing in the year 1736, by Robert Marsham, and which were continued until 1812 by his descendants of the same name. The record was again begun in 1836, and continued until the present time by the Rev. H. P. Marsham. This record of one hundred and forty years which we owe to the Marsham family has preserved innumerable notes in reference to botanical and other natural-history phenomena, and, for a greater portion of the time, the record was very full and careful, the first Mr. Marsham being an observant naturalist, and exceedingly fond of rural pursuits. An analysis of these observations has recently been presented by Thomas Southwell to the Naturalist Society of Norfolk and Norwich, who states that, as it has often been stated that "our old-fashioned winters have departed," and that the springs have become later, he has sought to test the question by taking the average days of the occurrence of twenty-five different phenomena indicative of the seasons during the years 1763 to 1774 inclusive. He did the same with the ten years ending

1874, and finds that the average date corresponding to the whole twenty-five phenomena is, for the eighteenth century, April 7, and for the nineteenth century March 28, showing that the springs are now nine days earlier than they were one hundred years ago. These dates are based respectively upon 196 and 181 observations; and it is not probable that the difference is owing to any fault of observing, but it is possibly due to drainage or cultivation. The extreme variability even of the English climate is illustrated by the range in the dates of certain phenomena. Thus, turnips are reported in flower December 25, 1846, and May 14, 1784. The wood-anemone was observed in flower March 9, 1775, and April 30, 1837. The average range of phenomena noted by Mr. Marsham is about seventy days.—*Transactions of the Norfolk and Norwich Naturalist Society*, 1875, 46.

METEOROLOGY IN NEW SOUTH WALES.

The private observatory of Mr. John Tebbutt, of Windsor, New South Wales, contributes to the meteorology of that part of the world a volume of observations made from 1867 to 1870, which observations have been recorded regularly at 9 A.M., and are supplemented by the records of self-registering maximum and minimum thermometers. The geographical position of the observatory has been determined by an extended series of observations of moon-culminating stars for longitude, and by observations in the prime vertical for latitude. The observatory is also connected by telegraph with the Sydney Observatory, which has, until recently, been under the directorship of Rev. W. Scott. The observatory of Mr. Tebbutt is situated on a hill near the centre of the peninsula at the eastern extremity of the town of Windsor. It is about 28 miles from the sea-coast on the east, and about 8 miles from the Blue Mountains on the west, and is surrounded by the forest except in its immediate neighborhood, where the soil has been cleared and cultivated for more than fifty years. Many of the meteorological instruments used in these observations were made in Sydney; others were brought from England, where they had been carefully compared with accepted standards. From the tables given in this volume of observations, it appears that the total amount of rain, as measured at Windsor, has been, in 1867, 44 inches;

in 1868, 27 inches; in 1869, 32.6 inches; in 1870, 62.5 inches. The evaporation from a basin of water, stationed seven feet above ground, amounted, in 1867, to 82.5 inches; in 1868, to 75.6 inches; in 1869, to 75.9 inches; and in 1870, to 60 inches. But the evaporation from a similar basin placed on the ground is about one half of these amounts. The highest average barometric pressures occur in April, May, June, and July, and the lowest average pressures occur in December and January. The highest temperature of the air recorded by the thermometer shaded from the direct rays of the sun occur in December and January, and reached, in 1867, 113°; in 1868, 113.6°; in 1869, 108°; and in 1870, 112.5°. The lowest temperatures recorded by the minimum thermometers shaded from the influence of radiation at night occur in July and August, and were, in 1867, 29.7°; in 1868, 24.8°; in 1869, 29.5; and in 1870, 29.6°.—*Meteorolog. Observations by John Tebbutt, Sydney*, 1874.

CARBONIC-ACID GAS IN THE AIR.

According to experiments that have been made by many chemists since the discovery of carbonic-acid gas, a larger per cent. of this substance is found in the atmosphere in the summer than in the winter, in the proportion of 71 to 48. Boussingault found that, out of ten thousand volumes of air, $3\frac{9}{10}$ were carbonic-acid gas during the day, and $4\frac{2}{10}$ during the night. Peligot having calculated the quantity of carbonic-acid gas that must result from the burning of oil and coal, from various industrial operations as well as natural phenomena, shows that there must be a large compensation, such that the gas produced by one class of operations is decomposed by another; so that it happens that the proportion of the gas in the atmosphere remains nearly constant, at least at the surface of the ground. The recent balloon ascensions in France have undertaken to determine the rate at which the quantity of gas varies with our ascent in the air. According to the experiments that had previously been made upon mountains, the proportion of gas diminishes slightly with the ascent in the air; but balloon ascensions have the special advantage that the observer is, by the balloon, carried far above the influence of the soil. The results of the first of the recent voyages in the "Zenith" gave, for carbonic-acid gas at 800 meters' altitude, 24 parts out of 100,000; and at 1000 meters, 30 parts out of 100,000. The difference between the two figures is the limit of the errors of observation.—13 *B.*, III., 333.

EARTHQUAKE IN THE VICINITY OF NEW YORK, DECEMBER 10, 1874.

On the 10th of December, 1874, an earthquake was felt in the neighborhood of New York, especially near Yonkers. It has formed the subject of study by the New York Lyceum of Natural History. From a report made to the Lyceum by Professor D. S. Martin, it appears that exact observations could not be obtained sufficient to give a definite basis for any physical investigation; showing, we may remark, forcibly, as is shown in a thousand other ways, the importance of having a uniform standard time, which shall replace the innumerable erroneous local times adopted in every portion of our country. Had each of Professor Martin's observers possessed a time-keeper set to correct time, he would have been able to add much of interest to our knowledge of the nature of this earthquake. In general, he states that the shock was felt from near Fishkill, southward, eighty miles, to Sandy Hook, and in an east and west direction from Morristown, New Jersey, eastward, sixty miles, to Stamford, Connecticut. The movement was felt far more strongly and frequently on rocky than on soft ground. In the main, the shocks seem to have been limited by the Highlands of New York and New Jersey. In only one case was the shock reported as felt on the water, which was by a schooner in the harbor of New Rochelle.

VOLCANOES IN ICELAND AND ASH-SHOWERS IN NORWAY.

A series of interesting volcanic phenomena has been, for some time past, in progress in Iceland, outbreaks having occurred from January to April. The eruption was steadily spreading over the wilderness, and so large a district of the surrounding country has been covered with ashes that the farmers have been obliged to remove, in order to find pasture for their stock. The eruption from the principal crater takes place through a fissure, from which the molten red-hot lava is thrown two or three hundred feet into the air, in one compact column. At times, twenty or thirty of these columns can be counted. A bluish steam accompanies the eruption, which rises straight into the air with great power, from many hundreds of fathoms.

In connection with this eruption, it is interesting to notice that during the nights of March 29 and 30 a heavy rain of ashes or sand took place along the west coast of Norway to the Swedish frontier, the whole country being covered with gray dust to such an extent that from a pint of snow more than a tablespoonful of residue was left after the snow had melted. The dust consisted of little irregular sharp-edged grains, principally silicates, and probably originated from the eruption in Iceland.—12 *A*, XII., 75, and XI., 575.

DRYNESS OF THE SOIL IN INDIA.

In a memoir on the waterworks at Nagpur, Central India, Mr. Binnie gives a large amount of information with reference to the variability of the rainfall in India and other countries; and among the investigations into which he entered was one illustrating the dryness of the soil during the dry seasons, and the consequent amount of water absorbed by it after every rainfall. An area of $6\frac{6}{10}$ square miles, or 4224 acres, was drained by trenches into a reservoir, and the height of water in the latter subjected to careful observation. Three rain-gauges were also placed within this area, by means of which the rainfall could be determined. It was found that in the case of a measured fall of 2.24 inches of rain which fell in one hour and twenty minutes on the 18th of June, there was no perceptible drainage from this area into the reservoir, while on the 16th of September, in the case of a rain of 2.2 inches, which also fell in one hour and twenty minutes, the drainage into the reservoir amounted to over 33,000,000 cubic feet. These opposite results prove the extreme state of dryness of the soil in India at the end of the heated season, and its complete saturation after the heavy rains of the monsoon period. Of the drainage observed on the 16th of September, 98 per cent. entered the reservoir within two hours and fifty minutes. As to the question what percentage of total annual rainfall drains from the ground and can be emptied into reservoirs, Binnie states that almost every drainage area has, in this respect, peculiarities of its own. Thus the average annual rainfall at Nagpur is 40.7 inches, of which 37.5 fall in the monsoon, and 3.2 in the dry season. Of this latter quantity, no part flows from the ground into the reservoir; and the records of the discharge of the drainage area are confined to about four months. The total depth evaporated during this time amounted to about four feet, or an average of about one fifth of an inch per day. The total loss of water during the season from the reservoir from all causes amounted to 104,000,000 cubic feet, out of which 55,800,000 cubic feet was evaporated, leaving 48,200,000 cubic feet as used or absorbed. An extensive comparison is given by the author between solar spots and India rainfall; but no very satisfactory conclusions are drawn by him.—*Minutes of the Institution of Civil Engineers*, XXXIX., Part I., 16.

MAGNETIC DISTURBANCES AND AURORAS IN THE ARCTIC REGIONS.

Lieutenant Weyprecht reports that the magnetic disturbances in that portion of the arctic regions visited by the Austro-Hungarian North Polar Expedition are of extraordinary frequency and magnitude, and are closely connected with the aurora borealis; the disturbance being the greater and quicker the more convulsive the motion of the rays of the aurora and the more intense the prismatic colors. Quiet and regular arcs, without motion of light or radiation, exercised almost no influence upon the needles. In all disturbances the declination needle moved toward the east, and the horizontal intensity decreased, while the inclination increased. Movements in an opposite sense, which were very rare, can only be looked upon as movements of reaction. Weyprecht had expected to be able to connect the aurora with the galvanic earth current; but being far distant from the land, he was obliged to bury his connecting plates in the ice, in consequence of which the movements were too feeble to be observed. A similar failure attended the attempt to observe the atmospheric electricity. He found that storms followed almost every time after intense auroras, and thinks he is justified in the conclusion that the aurora is an atmospheric phenomenon, and closely connected with meteorological conditions.—12 *A*, XI., 368, 397.

A NEW SEISMOMETER.

A seismometer devised by Malvosia, of Bologna, is thus described: On a slightly inclined board is fixed a spherical cap, having eight grooves corresponding to the eight principal points of the compass. A little beyond the edge of the cap there is a projecting wooden ring which limits the inclined surface. On the top of the cap is poised a little brass ball slightly flattened at the point of contact. Upon the ball rests very lightly a conical weight, by a small screw projecting from its base; which weight is suspended by a chain from an overhanging arm, movable up and down on a support at the side. The least shock will make the ball topple over. When it does so, it runs down one of the grooves of the cap to the inclined plane, at the lower part of which it finds a hole, and, passing into it, causes a gun to be fired off. After the ball leaves its position on the cap, a spring needle, longer than the diameter of the ball, shoots out from the little conical weight that rested on the ball, and catches in that groove of the cap down which the ball has run. Thus the direction is indicated from which the shock came. The instrument can be made very sensitive. It differs from that recently introduced by La Saulx into the earthquake stations of Prussia, principally in that the apparatus does not of itself record the exact time at which the shock took place, but merely calls the attention of the observer by means of the discharged gun. By combining the instrument of La Saulx with the simple upright pillar seismometer as described by Mallet, observations could be obtained which would be of more value than those given by the seismometer of Malvosia.—*Journal of the Franklin Institute, April,* 1875, 243.

THE MAGNETIC DECLINATION AT ST. PETERSBURG.

The long series of observations of magnetic declination that has been accumulating at St. Petersburg during the last 150 years has been subjected to a very full study by Mielberg, of that city, who has taken especial pains to examine the accuracy, reliability, and even genuineness of the observations, and to correct them for such sources of error as can be appreciated. The independent observations made by Nervander at Helsingfors, from 1844 to 1848, afforded him an excellent point of comparison, and the means of determining the diurnal period of the declination. The annual variations could then be investigated, and finally the secular. From twenty-two years of observations, between 1841 and 1862, he has thus been able to compile a table representing the normal hourly variations of declination for each month, and for the entire year; from which it appears that the greatest western declination occurs between one and two o'clock A.M. in every month, being a little earlier in summer and a little later in winter, with a secondary maximum just before two o'clock, and closely following the principal maximum. The greatest easterly declination occurs in the winter months between nine and ten A.M. During the rest of the year it varies between seven and nine A.M. The other maximum of easterly declination is not so decidedly expressed, and occurs in winter and spring between ten and eleven A.M. In respect to the secular variations of the declination, it would appear to have varied between two and a half degrees west in 1727, to six and a half degrees west in 1831, reaching its maximum about the year 1806, when it was about nine and a half degrees west. He suggests that if the increasing accuracy in our means of measurement is to have any meaning at all, and not be a useless expenditure of time and money, it becomes necessary now that, in any place where a magnetic observatory is surrounded by an assemblage of houses, there should be annually made, for purposes of comparison, an independent standard determination of the declination at some point near by but entirely outside of the buildings in question, and free from their influence.—*Wild's Repertorium*, IV., art. 1.

ATMOSPHERIC ELECTRICITY.

In reference to atmospheric electricity, Sir William Thomson states that if one ascend any mountain peak on a fine day, and there prove that the surface of the earth on the peak is negatively electrified, the result will be valuable to science; and if on several days the ground is found to be, all day and all night, negatively electrified, then there will be a very great acquisition to our knowledge regarding atmospheric electricity. According to him, positive atmospheric electrification of the air is merely inferential. What we know by direct observation is simply that the surface of the earth is negatively electrified; and many misleading and delusive statements in reference to the positive electricity of the air are to be found in encyclopædias and treatises on meteorology. Suppose, for a moment, that there were no electricity whatever in the air; that it was absolutely devoid of all electric manifestation, and that a charge of electricity were given to the whole earth—for which purpose no great amount would be necessary—such amounts as we deal with in our great submarine cables would, if given to the earth as a whole, produce a very considerable electrification of its surface. And suppose, in addition, which in fact seems to be shown by experiment, that all space above the atmosphere, and that the atmosphere itself were a non-conductor; then the charge could be given to the earth as a whole, just as a charge could be given to a pith ball electrified in the air of the room. Under these circumstances, all the phenomena that have thus far been brought to light by atmospheric electrometers would be observed just as they are. The ordinary observation of atmospheric electricity would give just the result that has been obtained from it. The results that we obtain every clear day in ordinary observations on atmospheric electricity are precisely the same as if the earth were negatively electrified, and the air had no electricity in it whatever. Ordinarily we have evidence in the lower strata of the air of the presence of negative electricity; but in rainy weather it is sometimes positive and sometimes negative.—*Journal of the Society of Telegraph Engineers*, 1874, III., 12.

THE DESTRUCTIVE FLOODS IN SOUTHERN FRANCE.

The terrible floods which swept over several hundred miles of the northern portion of the Pyrenees and the plains at their base, appear, in the light of later and more reliable accounts, to have been far more destructive to life and property than was indicated by earlier reports. The Garonne and its affluents, which drain the larger portion of the Pyrenees, seem to have risen with such rapidity that at Toulouse, as an instance, a low-lying suburb, St. Cyprien, chiefly inhabited by the working classes, was overwhelmed almost without warning, many people being drowned in the flood or crushed by falling buildings, and scarcely any property being saved. Another suburb shared a similar fate, but the inhabitants were fortunately able to escape with their lives. All along the course of the main river and its tributaries towns and villages were destroyed, some with hardly a vestige remaining, and the dead were numbered by thousands.

These destructive outbreaks have of late become periodical at Toulouse, but none have ever left such desolation behind as this one. Now for the moral of this pitiable story, and for the sake of which we have reproduced it. One cause of this terrible calamity, it is very generally conceded, is to be sought for in the wholesale destruction of the forests of the surrounding country, which has been going on for years. Our contemporary *Iron* puts the case concisely in the following terms:

The cause of this calamity is, no doubt, the three weeks' previous heavy and continuous rains, which fell over the whole range of the Pyrenees; the drainage of this rainfall having been accelerated by the stripping of the mountains and upland tracts of their natural clothing. We have on several occasions pointed out the way in which this excessive and unwise destruction of natural wood, among other and serious climatic evils, aggravates the effects of the rains which usually fall at the equinoctial periods, but are not confined to them. In the present case it appears that there has been a widespread destruction of timber in the district during the century, and thus the exceptional downfall, neither intercepted by the loosened earth and undergrowth, nor absorbed by vegetation, scarcely penetrates beneath the surface, but runs off as it falls, spreading desolation now, and occasioning drought later in the year. The latest estimate of the loss by these floods is 2000 lives in Toulouse alone, and about $75,000,000 worth of property. Twenty thousand persons likewise are estimated to have been rendered homeless and destitute, besides being deprived of the means of earning their bread.

CHANGES IN THE LEVEL OF THE WATERS OF LAKE GENEVA.

Professor Plantamour, of Geneva, has subjected to examination the observations made since 1838 on the heights of the water of Lake Geneva. These observations have been systematically and carefully made for forty years, and in all cases the bench marks to which the levels of the water are referred are points so well known that the entire series of observations can be considered as perfectly comparable among themselves, except in so far as a slight uncertainty attaches to a portion of the observations, due to an accident which occurred to the recording apparatus. After carefully correcting and reducing the whole series of observations to a uniform standard, it appears that the annual variation in the height of the lake is distinctly pronounced for each year of observation, but that the water returns to the same level at the same epoch of each year. The lake appears to have been lowest in December, 1857, and to have been highest in July, 1846; the entire range between these figures being only seven feet. It is, on the average, lowest on the 11th of February, and highest on the 7th of August. The connection between the accidental or extraordinary variations in the level of the lake, and the meteorological conditions, especially rain and melting snow, is fully examined; and it appears that the heat of the autumn is a very important factor in determining the volume of the waters of the Rhone, and consequently that of the lake. By means of a table giving the quantity of rainfall, and the temperature of the spring for each year as compared with the averages, Plantamour is able to explain away so large a portion of the irregular annual variations of height of the water that the remaining discordances are remarkably small; while there are groups of positive discordances, which have suggested the propriety of comparing the heights of the lake, year by year, with each other, in order to deduce the secular variations, if any exist. He has, therefore, divided his series into periods of nine years each, from which grouping it is shown that the level of the maximum water has not varied in any progressive manner in the course of thirty-six years, and that the annual fluctuations depend upon the dryness or wetness, the cold and the warmth of the year. If, however, within each of these groups, we compare the levels of the water, we find that the heights at low water are larger in proportion as the rainfall diminishes, and a gradual increase in the level of low water is noted, which can not be explained by atmospheric circumstances. These changes, it is suggested, are probably due to the modifications that have taken place in the course of years in the hydraulic works, and the drainage of the neighborhood. There seems to be no trace of such a change as Mr. Dawson states that he has found in the levels of the Great Lakes of North America, according to whom these vary in a period of about eleven years, following closely the changes in the solar spots.—*Mem. Soc. Phys. Geneva*, 1874.

THE ELECTRICAL CONDITION OF SPRING WATER.

Messrs. Theury and Minnich state that they have employed a delicate galvanometer in making some experiments on the electricity of the warm springs in Baden and Switzerland. One of the platinum electrodes was plunged into the upper spring at Stadthof, and the other electrode into the little stream Limbat. As soon as the metallic connection was completed, the needle of the galvanometer moved violently, oscillating about 74°; then in proportion as the electrode was covered with bubbles of gas, and became polarized, the galvanometer needle descended to 72°, and even to 60°, ascending to 70° when the electrode was cleansed of bubbles with a brush. This experiment shows that the thermal water was very strongly electrized, the source of the water being negative. Again, placing two vases of water side by side, the first vase filled with spring water, taken immediately from the source and still quite warm, the second vase filled with cold water from the river, the platinum electrodes were introduced, and immediately the needle of the galvanometer indicated a current flowing from the cold to the warm vase; that is, in the same direction as the current of the spring, the warm spring water being electrized negatively. When the spring water had completely cooled, it was again heated with an alcohol lamp to a temperature of 47°, and the electrode immersed, but without observing any appreciable current in the galvanometer.—1 *B*, XV., 411.

ON THE SECULAR DIMINUTION IN EUROPE OF SPRINGS, RIVERS, AND STREAMS, WITH THE SIMULTANEOUS INCREASE IN THE FLOOD WATERS IN CULTIVATED LANDS.

A memoir by Gustave Wex, published at Vienna in 1873, on the diminution of water in springs and rivers, and the increase in the flood waters in cultivated lands, has lately been the subject of a report by the Vienna Academy of Science, from which it would appear that the diminution experienced in the course of the last few centuries in the average height of the water (especially the low waters) of the Rhine, the Elbe, and other rivers of Europe, is to be attributed to a diminution in the annual quantity of water available for the rivers, and taking account of the amount of evaporation, there still results a diminution in the amount of water supplied by springs and rainfalls. It appears to the commission probable that the influence of forests is perceptible on the annual rainfall, and especially on the distribution of the rain throughout the year, although direct observations do not yet suffice to determine the magnitude of this influence. Among the causes tending to this diminution of the water in the rivers, the commission enumerate, first, the extinction of the forests, which exerted a beneficial influence in maintaining and elevating humidity, in diminishing the extremes of temperature, and diminishing the evaporation, and in assisting to a more equable drainage of the precipitation. A second cause is found in the drying up of the lakes, ditches, and morasses, which also would have exerted an influence similar to that of the forests. Third, in the cultivation of extended areas of land, which cultivation demands the consumption of considerable quantities of water. Fourth, in the increase of population, although the effect of such increase can directly account for only a slight percentage of the entire diminution. Finally, the commission consider the suggestion of Salmann as worthy of consideration, according to whom water is being employed in the interior of the earth in the formation of minerals which contain that liquid in chemical combination. In view of these considerations, the commission recommend that the Austrian government institute such observations as will lead to a further knowledge on this subject, and especially take such steps as will prevent the further diminution of water from becoming a calamity to future generations. Efforts will also be made to collect more complete data from the inhabited portions of the world; and especially is the hope expressed that the Viceroy of Egypt may cause tables and graphic representations to be made of the observations on the height of the water at the Nilometer at Cairo, where such observations have been regularly made for the past 3000 years.

The actual diminution in the annual average height of the water, as deduced by Wex, is, for the different parts of the Rhine, from 6 to 60 inches during fifty years; for the Elbe, at Magdeburg, 17 inches; for the Oder, 17 inches; and for the Donau from 18 to 55 inches. — *Sitzungsbericht der Akademie der Wissensch.*, *Vienna*, LXIX., *April* 23, 1874.

PHOTOGRAPHING THE WAVES.

The various mathematical theories that have been, thus far, elaborated with reference to the movements of vessels upon the waves are only approximate. It is only by experience that we are able to determine to what degree of exactness these theories have arrived, and in order to verify them it is necessary to register the successive inclinations that a wave gives to a vessel. The photograph allows us to obtain the law of these inclinations. Let us suppose that a photographic apparatus, having its axis perpendicular to the diametral plane, be directed toward some point in the horizon. We should obtain on the sensitive plate an image of the sea and of the heavens, separated by a horizontal line, which would be the image of the horizon. Let us mark upon the plate the position of this image when the axis of the apparatus is upright. If it is then inclined by an angle, i, about a horizontal axis parallel to the diametral plane, the image of the horizon will remain parallel to the primitive line, but be displaced by a quantity equal to f, tang. i; f being the focal distance of the objective. Let us suppose now that we place before the sensitive plate a fixed shutter pierced with a vertical slip; the image will be intercepted, except in that part of the plate situated behind the slip. We shall thus have upon the plate a broad band of two different tints corresponding to the sky and the sea, divided by a segment of the horizontal line. Consequently, if we take an instantaneous photograph at the moment when the ship is inclined at the angle i, we shall have a segment of the horizon line, and the distance of this line from the primitive horizontal line will give the angle i. In order to realize these conditions, it suffices to make the sensitive plate move horizontally with a uniform movement. If, during this movement, the vessel remains vertical, the segment of the image of the horizontal line will continue at a constant height upon the plate. Consequently it would trace upon the plate a horizontal line. Let us suppose now that the ship rolls; at each instant there would be a certain inclination, *i*, and at this moment a certain zone of the plate will be found behind the opening of the shutter. The image of the horizon will traverse this window at some point of this zone, and it will fall upon the plate at a distance from the reference line equal to *f*, tang. *i*. Experiments have been authorized according to this method, which is the invention of Huet, at Brest, and the photograph proofs show the good results that were obtained.

BAROMETRIC OBSERVATIONS ON THE OCEAN.

Dr. Buys Ballot communicates in a preliminary way the results of the great unpublished work undertaken by the Meteorological Institute of the Netherlands, and which consists in the derivation from over three hundred thousand observations on board vessels of the average barometric pressure for each month, and for every five degrees square throughout the navigated portions of the North and South Atlantic Oceans. The average barometric pressure within ten degrees of the equator is 760.04 millimeters. The pressure within ten degrees of the parallel of 30° north is 765 millimeters; and within ten degrees of the parallel of 30° south it is 762.5. Beyond these latter parallels the pressure diminishes steadily toward the poles, and is, apparently, at the limits of Buys Ballot's tables, viz., about 50° of latitude, in the southern hemisphere, 750 millimeters, but in the northern hemisphere 760.—*Oesterreich. Zeitschrift für Meteorologie*, X., 159.

THE SMALL OSCILLATIONS OF THE BAROMETER.

Hon. Ralph Abercrombie has examined the connection between the wind and the small oscillations of the barometer. He finds, for example, that with an open window looking south and the wind nearly south, in strong gusts the first movement of the barometer is always upward, and about one tenth of an inch, as if the effect of the wind on being resisted by the house was to compress the air in the room. In a corner house, one window open to the south and another to the west, the wind south, in strong gusts, with the west window open, there were violent oscillations; but the first movement was always downward. Upon opening the south window as well as the west, the oscillations ceased. It is well known by medical men that some acute diseases are aggravated by strong winds; and the author has observed that this distress is associated with those small oscillations of the barometer. He suggests the following practical method of palliation. If windows can not be borne open, try, by closing or by otherwise arranging windows and doors, to diminish the distress. When, as in most cases, windows can not be opened, all doors and windows should be closely shut, as well as the vent of the chimney if there is no fire; and, if possible, the patient should be removed to a room on the lee side of the house.—12 *A*, XII., 78.

ON THE DISTRIBUTION OF BAROMETRIC PRESSURE IN EUROPEAN RUSSIA.

The well-known work of Buchan, published in 1866 by the Royal Society of Edinburgh, was the first that offered an extensive collection of barometric observations, and gave the first approximate idea of the correct isobaric lines throughout the whole world as drawn for every month in the year, and for the average of the entire year itself. While Buchan in this work sought to obtain greater accuracy by using only the observations made between 1850 and 1860, he was, however, frequently thrown into serious error by the uncertainties of the altitudes above sea-level of the stations in the interior of Europe and America. For the latter country annual barometric means have been of late published by the Army Signal-office; and we have now to record the appearance of an important work by Rikatcheff, on the distribution of barometric pressure in the interior of European Russia. The author states that, as regards Asiatic Russia, we have still too little material to justify the drawing of isobaric lines as Buchan has done. For European Russia he gives many, and in some respects important corrections to the figures employed by Buchan. Having personally inspected many of the Russian stations, Rikatcheff has been able to discriminate between the observations that are reliable and those which should be rejected; he has collected all the valuable barometric observations that have been made in

Russia, and has applied to those stations whose altitudes were correctly known by levelings the barometric reductions (as computed by Rühlmann's formula) necessary in order to reduce the observed pressures to the theoretical sea-level. The highest station to which he has applied this process is Tiflis, whose altitude is about 1500 feet, and at which altitude he states the reduction to sea-level already becomes quite uncertain. The longest series of observations employed by him is, for the Russian stations, that at Warsaw, embracing thirty-three years. Having reduced the annual pressures to sea-level for these stations, he has, by means of preliminary approximate isobars, determined the mean annual pressure at sea-level for the other stations whose altitudes were not correctly known, and has there computed the altitudes as dependent upon long series of good observations, of five interior stations, with a probable accuracy of less than forty feet, and has determined the altitude of eight other stations with an error of less than ten feet. These secondary stations thus became valuable in the formation of the monthly isobars, although, of course, they can not be used on the annual charts. The final charts thus completed by Rikatcheff present the same phenomena as those given by Buchan, but of not quite so extreme a nature. The change from a very high pressure in the interior of the continent during the winter to a low barometer in the summer time is very decidedly marked (the explanation of this phenomenon given by Rikatcheff is too much at variance with mechanical laws to escape severe criticism). On the other hand, the annual chart shows a well-marked diminution in the average barometric pressure as we proceed northward. Its depression he attributes to the numerous cyclones that occur in this region, although he states very plainly that the average annual temperature, as well as the tension of aqueous vapor, should conspire to annul this effect. It is probable that at the time of composing his memoir he had not yet become acquainted with the writings of Ferrel, Thomson, Peslin, Colding, Everett, and others, by whom the depression of the barometer in the polar regions of the earth is very accurately explained as due to the rotation of the earth on its axis, combined with the general atmospheric currents. Ferrel has even explained, in a very perspicuous manner, the reason why this depression is so much greater in the antarctic than in the arctic regions. One of the most important practical results attending the publication of Rikatcheff's memoir is the stimulus that it has given, and probably will give, to the application of Rühlmann's methods for the determination of altitudes by means of the barometer. According to this author, we should, if possible, employ only monthly or annual means for determining altitudes barometrically, and should (especially when only a few observations are available) employ the readings of the barometers at two or more known stations in order to deduce therefrom the temperature of the air without relying on thermometric observations. From the isobaric charts given by Rikatcheff we can find the average normal height of the barometer for any month whatever in Eastern Russia within less than one twenty-fifth of an inch, and in Western Russia within one fiftieth of an inch, and the average annual mean pressure of any point in Western Russia within one one-hundredth of an inch.—*Wild's "Repertorium,"* IV., art. 6.

ON THE TIDES IN THE ROADSTEAD OF FIUME.

In a recent prize essay by Professor Stahlberger on the tides in the roadstead of Fiume, the author, from a study of observations extending over thirty-seven lunations made by means of a self-recording tide-gauge, shows that with a rising barometer there occurs a diminished height of water, and, conversely, with a diminished pressure an increased height of water. In connection with the barometric pressure, the northerly and southerly winds exert their influence to respectively increase and diminish the water level. With the southern winds, the curves showing the height of the water are comparatively smooth and regular. With the northerly winds, however, they vary according to the strength of the wind, showing greater or less irregularities. The periodic movements of the ocean level are subject to two principal oscillations, depending on the moon, and two other principal ones depending on the sun. The regularity of this phenomenon is complicated very much by the fact that the tidal waves that reach Fiume come from the Mediterranean. The reason why the twenty-four-hour oscillation is comparatively large, while the twelve-hour is weak, depends, according to Stahlberger, upon the configuration of the Adriatic Gulf.

It is probably thus that we explain the fact that the ratio between the mean influence of the sun and the moon is, for Fiume, 1.86, instead of its theoretical value, 2.55, as was to be expected. The known effects of the tides at Trieste are similar to those at Fiume.—"*Mittheilungen*" *Austrian Hydrographic Office*, 1874, 723.

THE DIURNAL AND ANNUAL PERIODICITY OF THE MOISTURE IN RUSSIA.

Professor Wild, of St. Petersburg, has communicated an extended investigation into the atmospheric humidity as recorded at the Russian meteorological stations, a study which may be looked upon as a continuation of his previous memoir on the distribution of cloudiness in Russia. He finds that the diurnal changes in relative humidity are intimately connected with diurnal changes in temperature, so that a maximum of temperature coincides with a maximum relative humidity, and *vice versa*. Furthermore, the amplitude of the daily oscillation in humidity has direct relation to the changes in temperature. The diurnal changes in absolute humidity have, however, a much less decided connection with the temperature. The annual changes in both absolute and relative humidity are given by monthly means for forty-one stations. The annual changes in absolute humidity may be directly connected with the temperature. The causes of the various annual changes in humidity in different portions of Russia are explained by Wild in connection with the seasonal distribution and changes of atmospheric pressure and winds.—*Oesterreich. Zeitschrift Meteorologie*, X., 258.

ON THE ACCURACY OF ANEMOMETERS.

One of the most important and, at the same time, popularly interesting matters relating to meteorology, or rather to the mechanics of gases, is the relation between the pressure and the velocity of winds; which subject, notwithstanding the elaborate researches, both experimental and theoretical, that have been made since the days of Lambert, is still far from being satisfactorily resolved. The numerous experiments seem uniformly to show that the measured pressures of fluids against the surfaces opposed to them differs from those predicted by theory. The principal source of discordance is probably to be found in the fact that the computations take account only of the pressures against the front surface of the solid, while the reaction that takes place on the hinder surface is partly or even totally neglected. In the case of the anemometers employed for the purpose of measuring the velocity of the wind, probably without a single exception, their indications must be interpreted by means of approximate empirical formulæ; and no other method has, as yet, been devised by which the indications given by pressure gauges can be compared with those given by velocity meters. Of these latter instruments, the best are those known as Robinson's anemometer and the Casella anemometer. Of the pressure gauges, those most commonly in use are the Ossler anemometer and Wild's anemometer. Dr. Dohrandt has recently undertaken, at the instigation of Dr. Wild, of St. Petersburg, an elaborate investigation, both theoretical and experimental, into the sources of error peculiar to these instruments; and the memoir embracing his results, which was announced a year ago by Professor Wild, seems to be the most valuable contribution to anemometry that we have had occasion to regard since the appearance, in 1873, of Cavallero's investigations, which were noticed by us at the time. (See *Annual Record*, 1874, p. 104.) Unfortunately, Dr. Dohrandt was interrupted in his labors by a call, on the part of the Russian Geographical Society, to superintend the establishment of meteorological stations in Asia; but Professor Wild assures us that his researches will be continued by the Physical Observatory, until definite conclusions can be considered as established. Among the means adopted for comparing the actual velocity of the wind with the readings of the anemometer, Dr. Dohrandt experimented first with the method adopted thirty years ago by Duchemin, and less thoroughly by others, and which consists in carrying an anemometer attached to a locomotive, the velocity of whose movement is well ascertained. The railroad from St. Petersburg to Tsarskoe Selo offered a good opportunity for the experiment which was first made on July 1, 1871, in which the average velocity of the railroad train seems to have been from twenty-one to forty-eight kilometers per hour. During the experiment the average velocity of the wind itself, in the direction of the path of the locomotive, was two and eight-tenths kilometers per hour; and the velocities observed by timing the train as it passed each mile-post agreed with the velocities recorded by the anemometer to within two per cent. A more definite method of investigation, however, is that of Combes, which consists in attaching the anemometer to a long arm, which latter is made to revolve in a circle at a known rate, in a space where strong currents of air do not occur. Velocities up to forty kilometers per hour were attained in this way by Dohrandt; and from the investigation of six different Robinson's anemometers, and of two of Casella's instruments, and of a number of electric recording anemometers, it was concluded that the arithmetical mean of the indications of an anemometer, when the arm which carried it revolved in both a positive and a negative direction, might be adopted as the result that would be given if the instrument had simply moved in a straight line. The determination of the effect of the moving anemometer upon the air surrounding it—an effect which it is known consists essentially in carrying the air with it, and thereby diminishing the relative velocity of the air and the instrument—was first made by placing a Casella and a Woltman's anemometer on the same level with the rotating anemometer, but fixed in their positions, and so near to the circle described by the latter that they could feel the influence of the wind dragged along by the Combes' apparatus, and be thereby set in motion. As the result of this portion of his investigation, Dohrandt finds that the wind due to the dragging influence of the moving anemometer is very approximately proportional to the velocity of the latter itself. As a final result in reference to the velocity of the anemometers, Dohrandt gives a formula applicable to each one individually, by means of which the true velocity may be computed from the indications of the dials of the instruments. Having thus some half-dozen well-investigated instruments as standards, it becomes easy to compare numerous others with these. The result of such comparison showed that the errors determined in this secondary manner were of the same nature and expressed by the same formula as those determined by the original investigations. In general, in relation to the velocity of the anemometers, Dohrandt finds that the centre of the revolving caps of the Robinson instrument, instead of describing exactly one third of the path of the wind, as they should do according to the theoretical researches of that astronomer, differ from this to such an extent that the indications of their dials must be multiplied by numbers varying from 2.1 to 2.9 in order to deduce the true velocity of the wind. The result most to be desired in relation to this branch of anemometry is the determination of the relation between these varying factors and the actual dimensions of the respective instruments. But Dr. Dohrandt finds, as had Cavallero and Stowe before him, that no such relation can be discovered; only so much is easily seen, that the magnitude of the factor is in more direct connection with the diameter of the hemispherical caps than with the length of the arms of the anemometer. In respect to the pressure of the wind, Dohrandt experimented with six different specimens of Wild's wind-pressure anemometer, which consists simply of a very thin plane piece of iron or wood, or thin cardboard, hanging by a very thin arm from a pivot, and which is by the force of the wind pushed aside from its vertical into an inclined position. The angular extent of the deflection is measured in degrees by an appropriate divided arc. In connection with this, he calls attention to the fact that the indications of this, and of all pressure instruments, are decidedly affected by the density of the atmosphere, as indicated by the barometer. The comparisons of the indications of this pressure gauge with the velocity deduced from the standard anemometers seems to show that the simple instrument of Dr. Wild suffices, by means of the table given by Dohrandt, to determine the velocity of the wind within less than about one half a meter per second. On account, therefore, of its simplicity and inexpensiveness, it is probable that this instrument will be widely used throughout the world, especially as it has now been introduced at all the Russian meteorological stations, and at many of those in southern Europe.—*Wild's* "*Repertorium*," IV., art. 5.

THE SELF-REGISTERING BAROMETER OF REDIER.

Among the many contrivances brought forward during the past few years for the self-registration of meteorological instruments, that of Redier seems both economical and applicable to many cases where more troublesome apparatus would be out of place. His arrangement consists essentially in such an alteration of the well-known printing barometer constructed by G. W. Hough, of Albany, that the use of electricity is done away with, and, on the other hand, the fulcrum of the principal lever in the apparatus is fixed, while the barometer tube itself, or the aneroid box, moves. The numerous specimens of the apparatus constructed by Redier for individuals in France seem to have given very general satisfaction, and the instrument has been highly commended to the attention of French observers. It consists essentially of a clockwork by means of which a cylinder is made to revolve uniformly, carrying with it a sheet of paper upon which the record is to be made. Above the cylinder stands the barometer, which is so arranged that the rise and fall of a thousandth part of an inch causes a lever to rise or fall by a corresponding movement, thereby releasing the detent of an auxiliary piece of clockwork, which is thereby at once set in motion. The movement of this clockwork allows the barometer tube itself to fall or rise, thereby again interfering with the movement of the clockwork and automatically stopping it. Meanwhile the up or down movement of the barometer has been closely followed by the corresponding movements of a pencil, whose mark on the sheet of paper produces an exact record of the extent of the barometric change.—13 *B*, III., 267.

DO STORMS CROSS THE ATLANTIC?

Mr. Ley states that, having worked for a considerable time at the comparisons of United States with European weather charts, he concludes that only a small portion of the storms experienced on the American side of the Atlantic can subsequently be distinctly traced in Europe. Of those thus traceable the majority are felt severely in the extreme north of Europe. The rapidity of the progress of these storms across the Atlantic varies indefinitely, and could not be deduced, as Mr. Draper has attempted, from the velocity of the winds experienced in them. Many of the most destructive European storms occur when the barometric pressure over the eastern portion of the United States is tolerably high and steady, and they appear to be developed upon the Atlantic

Ocean, near the eastern limits of the area of high pressure.—12 *A*, 405.

GLACIATION OF ICELAND.

In the opinion of Mr. William L. Watts, who is engaged in making some explorations among the glaciers of Iceland, these are increasing year by year; and he thinks that at no distant period the whole island will be covered with ice, as is the case with Greenland.—13 *A*, 193.

GLACIERS OF THE HIMALAYAS.

At the recent meeting of the British Association Colonel Montgomerie gave an account of the glaciers of the Himalayas, which are most developed in Baltistan, in Northwestern India. According to his statement, these glaciers gradually increase in size from east to west, many of them being more than twenty miles in length, and one, Biafo, thirty-four miles. The thickness of the ice was in some cases found to be 400 feet. The phenomena of progress, etc., were found to be similar to those observed in the Alps.—15 *A*, *September* 4, 314.

TIDES OF THE MEDITERRANEAN.

The tides of the Mediterranean form the subject of a prize essay by Stahlberger, of Hungary. The author especially dwells upon observations and discussions relating to the peculiar local influences in the neighborhood of the port of Fiume, on the shores of the Adriatic. Pursuing an inductive method, he shows the existence of general changes of the water produced by cosmical causes, and local changes due to meteorological or local agencies. Of the former there are principally two oscillations dependent on the sun, and two on the moon. The local changes are caused chiefly by variations in the wind and the barometer. In stating this view, he seems not to have gone beyond what Mr. Ferrel has already published with reference to the Atlantic.—"*Mitth.*" *Austrian Hydrogr. Office*, II., 723.

DAILY WEATHER CHARTS.

The dissemination of valuable meteorological intelligence has been remarkably facilitated in England by the daily publication, in the London *Times*, of a small weather chart, showing the temperature, wind, barometer, and weather, and the condition of the sea for the region within about five hundred miles of London. This chart is prepared daily by the London Meteorological Office, and furnished gratuitously to the newspapers. The stereotype plate, fit for use in a Walter printing-machine, is produced in about an hour. It is now more than four years since a similar undertaking, on a somewhat different scale, was set on foot by Sir William Mitchell in the *Shipping Gazette* of London, and which has been continued daily.

CONNECTION OF WEATHER AND COLLIERY EXPLOSIONS.

Messrs. Scott and Galloway, of England, have continued their researches into the connection between colliery explosions and the weather. As the result of the study of two hundred and twenty-four explosions, they state that the amount of fire-damp recorded in the mines increases and diminishes directly as the barometer falls and rises, proving beyond the possibility of cavil that the variations of atmospheric pressure have a marked influence on the rate at which fire-damp escapes from fissures. In the large majority of the fatal explosions the miners were using naked lights; and they suggest that if fire-damp is known to be present in any part of the mines, then either the workmen should not be allowed at any time to be near it, or else they should use safety-lamps in its vicinity, at least during the continuance of the barometric depressions. They also suggest the interest and value that would attach, both in a scientific and a practical point of view, to the keeping at coal-mines of barometric records, such as are daily furnished by the self-recording apparatus which can now be obtained from every meteorological office.—*Quart. Jour. Met. Soc., London*, II., 195.

THE HOURLY DISTRIBUTION OF RAINFALL.

Among the very few meteorological stations at which the rainfall has been recorded either continuously or hourly is to be noted that of Berne, in Switzerland, the observations at which place for the past eight years have recently been studied by Forster. The diurnal periodicity of rainfall, both as regards its quantity and its frequency, follows at this place a regular law, and, on the average of the year, it is shown that the probability of rain increases from one o'clock in the morning to a maximum at seven o'clock in the morning, then sinks to a minimum at two o'clock in the afternoon, and rises again to a maximum at midnight. The diurnal period is thus almost opposite to that which obtains under the tropics, where in the afternoon, at the hour at which the temperature is at its maximum, and at which the clouds are, on the average, the highest above the earth, it rains most frequently.—19 *C*, VII., 234.

PERIODICITY OF SEVERE WINTERS.

A memoir by Rénou, the distinguished French meteorologist, upon the periodicity of severe winters, although published many years ago, has been recently quoted in defense of the opinion that such periodicity actually exists. According to Rénou, rigorous winters return about every forty-one years. They are arranged in groups, generally composed of a central winter, and four or five others disposed on either side of it, within a space of twenty years. Mixed with these years are others, also, of unusual warmth, in such a manner that the mean cold of the season is not sensibly altered. The period of forty-one years seems to be that which corresponds to the maxima of the solar spots at the same season of the year. A central cold winter arrives eighteen months after the maximum of spots has coincided with the warmest season of the year. The severe winters seem to alternate between the northern and southern hemispheres of the earth. —13 *B*, 135.

ORIGIN OF THE CENTIGRADE THERMOMETER SCALE.

According to the historical notes contained in the meteorological observations of Lafou, president of the Meteorological Commission of Lyons, the first thermometer that was ever seen at Lyons was brought thither in February, 1736, by Duhamel, to Father Duclos, director of the observatory founded by the Jesuits in the chapel of their college. This thermometer was constructed with alcohol, according to the principles of Réaumur, and was used for some time. A member of the Academy of Lyons, named Christin, replaced the alcohol by mercury, as had, indeed, previously been done by Fahrenheit in 1724, and by Dr. Sauvage at Montpelier in

1736. Christin having introduced into a tube terminated by a bulb a quantity of mercury, whose volume might be represented by 6600 at the temperature of freezing water, found that this volume became 6700 when the tube was plunged into boiling water. The alcohol of the original thermometer being thus dilated 100 parts, Christin divided the corresponding space passed over by the mercury into 100 equal parts, remarking that these new divisions, being smaller than those of Réaumur, would be more in harmony with the sensations caused by variations of temperature. Such was the origin of the Centigrade thermometer, which was afterward known for a while under the name of the "Thermometer of Lyons." Four years after—that is to say, in 1746—Cassini, who was a well-known optician at Lyons, had sold seven hundred of these in Paris, besides others in Provence and Dauphiny.—13 *B*, III., 94.

PERIODICITY OF HAIL-STORMS.

The tendency which has been so marked of late years to look for a periodicity in almost every natural phenomenon corresponding to the periodical increase and decrease of the solar spots, seems to have been carried to its fullest extent in the recent suggestion of Professor Fritz, according to whom the frequency of hail-storms has some connection, accidental or otherwise, with the frequency of solar spots. He finds, by collecting the records from twenty-five different European and other stations, that all observations show that the years of greatest frequency since 1806 have been 1817, 1830, 1838, 1848, and 1860, which years follow or are nearly coincident with the sun-spot maxima of 1817, 1829, 1837, 1849, and 1860; whence it would follow that the year 1871, a year of sun-spot maximum, should be also a year of frequent hail-falls, as actually was generally recorded. Furthermore, seasons of infrequent hail-storms correspond to the minimum of solar spots, as in 1810, 1823, 1834, 1844, and 1856. It has also been often remarked that a winter of extensive or frequent auroras is followed in the succeeding summer by unusual hail-storms. The connection between auroras, lightning, hail, and cirrus clouds and the solar spots seems, therefore, worthy of further study.—7 *C*, XV., 244.

FIGURES MADE BY LIGHTNING.

Professor Tomlinson, in writing on the subject of the figures or marks left on the bodies of men or animals killed by strokes of lightning, states that very instructive tree-like figures may be produced on sheets of ground glass by passing over them the contents of a Leyden-jar. These figures, like those on the human subject, are not derived from any tree whatever, but represent the path of the lightning itself. This subject has been studied by numerous authors; among others by Poey, who, in 1861, published a small volume, in which twenty-four illustrative cases are cited. He accounts for their formation as a photo-electric effect, in which the surface of the animal is the sensitive plate, the tree, etc., the object, and the lightning the force that impresses it. Among many remarkable cases that can be quoted was one that occurred at Zante, where the mast of a vessel was struck, and a sailor sleeping in a cot on the deck was killed. The number 44, in metal, was attached to the fixed rigging between the mast and the cot. On the left breast of the dead sailor was found the number 44 well formed, and perfectly identical with that on the rigging. Light was thrown upon these cases by Mr. Varley, who, noticing some specks on the metallic ball of the positive pole of a Holtz electric machine, tried to wipe them off with a silk handkerchief, but in vain. He then examined the negative pole, and discovered a minute speck corresponding to the spots on the positive pole. It was evident that lines of force existed between the two poles, by means of which, as it were, telegraphic communication was made from one to the other; and in explanation of the marks made on the human subject, it is stated that a lightning burn on the skin is produced whenever the object struck is electrically positive to the metallic object, the discharge itself being a negative one.

CLIMATOLOGY OF FLORIDA.

In an address on the climatology of Florida, recently delivered by Dr. Baldwin, the author gives some interesting statistics, whose value is indicated by the fact that they are based upon thirty-six years' meteorological observations, recorded by himself, at Jacksonville, together with numerous shorter records from the stations in other portions of the state. He states that the first frost has occurred in the fall in October four times in the course of these records, in November sixteen times, and in December seven times. There have been several years in which there have been no frosts in October. There have been three years in which none has occurred in November nor December. Of late frosts he says that there have been very few in April, and none after that. The latest on record is that on the 28th of April, 1858. There have been but four Aprils and but four Octobers in which frosts have been recorded. From these statements an idea can be formed of the average amounts of freezing weather in winter. Frosty days occur, on the average, about five days in each of the months of December and January. As to clear days, he states that from November to March there is an average of twenty clear days per month; but for June, July, August, September, and October an average of from seventeen to nineteen days. Of rainy days there are in January six or seven, in February three or four, in March five or six, and in December five. "I judge," Dr. Baldwin says, "that, on the whole, the preponderance of clear over rainy and cloudy days speaks decidedly in favor of our climate as being characterized by a fair amount of pleasant weather. The excessively cloudy weather of January, 1875, is a marked exception to all former years since my residence in Florida, and has most probably resulted from some general disturbance of the atmosphere, which has produced such intense cold in the Northern States as will probably be remembered hereafter as one of those cold winters which at long intervals will visit a country, and which on many accounts may be considered as a 'blessing in disguise.'"—*Baldwin's Address*, 1875.

C. GENERAL PHYSICS.

ATTRACTION AND REPULSION RESULTING FROM RADIATION.

Mr. Crooks has lately published his investigations into the phenomena known as attraction and repulsion resulting from radiation. The apparatus constructed by him appears to be more sensitive than the ordinary thermo-multiplier. He considers that the experiments show that the repulsion is not entirely due to the rays usually called heat, viz., to the extreme and ultra red rays of the spectrum. The theory advanced by Professor Reynolds to explain his observations is not acceptable to him, although, on the other hand, he has not yet prepared one of his own. According to Reynolds and Balfour Stewart, these experiments constitute a direct proof, and the only known direct proof of the truth of the kinetic theory of gases as developed by Clausius and Maxwell.

Mr. Crooks has adapted his results to the construction of a very important instrument, which he calls a radiometer. It consists of four arms suspended on a steel-pointed axle resting in a cup, so that the arms are capable of revolving horizontally. To the extremity of each arm is fastened a thin disk of pith, lampblacked on one side, and the whole is inclosed in a very perfect vacuum within a glass globe. Under the influence of light, or heat, the little arms revolve with considerable rapidity. Mr. Crooks states that the repulsion experienced by these disks when any radiation falls upon them is proportional to the length of the vibrations, and varies at every point of the spectrum. Professor Guthrie has remarked that Mr. Crooks's research had, in an almost unequaled degree, every element of greatness.

INCREASE OF RADIATION WITH TEMPERATURE.

It is well known that as the temperature of a solid is gradually increased, the refrangibility of the emitted light increases likewise, and as the result we find red light emitted first; afterward the other colored rays gradually appear as the heat increases, until we reach the ultra-violet rays. This correlation between refrangibility and temperature was first experimentally proved by J. W. Draper, and it would be a result of great importance to determine the law of growth of refrangibility with temperature. If this could be achieved, a very convenient and accurate pyrometer could be made of the ordinary spectroscope. An accurate investigation of this subject has been undertaken by a committee of the British Association, which has in a preliminary report presented some observations on the simple increase of radiation with temperature. On this subject Becquerel has a great number of observations, whence he infers that the differences between the logarithms of the luminous intensities are proportional to the differences of temperature, a law which he thinks would hold up to 1200 degrees Centigrade; but the law as thus expressed mathematically by no means represents the true rate of increase of the total luminous intensity, which is, indeed, very much slower than that required by Becquerel's law. Again, if the law of Dulong and Petit for the velocity of cooling be true, then the amount of heat radiated, as also the temperature, could be calculated; but on comparison with actual observations at high temperatures it is found that their law gives too rapid an increase for the total radiation. Assuming, however, these laws to be even approximately correct, we may calculate the hypothetical temperature corresponding to the brightness and total radiation from the sun, and deduce in one case for the solar temperature 13,000, and in the other case 11,000 degrees Centigrade. —*Report of the British Association*, 1873, 461.

THE DIFFUSION BETWEEN DRY AND MOIST AIR.

An investigation that may have some interest in the future of meteorology has been conducted by Dufour, who has examined the question of the diffusion between dry and moist air traversing a porous disk. He finds that the activity of the diffusion does not depend directly, except possibly in a very slight degree, upon temperature. If we compare the observations made at different temperatures, we find that the activity of the diffusion also does not depend, with slight exception, upon the relative humidity; it depends principally upon the difference between the quantities of vapor, or the tensions of the vapor, on the opposite sides of the disk, and is in fact very nearly proportional to the difference of the tensions. If, then, we compare observations made at the same temperature, the activity depends upon the relative humidity of the two portions of air. The study of the influence of the diaphragm, its extent, etc., has enabled him to explain how a small porous vase can, by connecting its interior with a manometer, be utilized in studying the diffusion of vapor in the free atmosphere. Similarly, we may determine the tension of the vapor of water existing in the air, at any moment, by determining the difference of the pressures shown by the monometer in the interior, and by the barometer on the exterior. This suggests a new hygrometer, which, simple as it is, and easily applicable, may rapidly find favor among meteorologists so soon as Dufour has exactly developed the laws connecting the relations of pressure and the hygrometric state of the atmosphere.—*Bibl. Univers. et Revue Suisse*, 1874, 336.

ON THE LAWS OF APPARENT ADHESION.

Stefan, who is well known as one of the most industrious investigators in all matters relating to molecular physics, has recently published in full a memoir relating to preliminary investigations on the subject of adhesion. The true phenomena of adhesion are easily confounded with what he calls apparent adhesion. That is to say, if two perfectly flat plates be brought quite near together, but not in actual contact, and an attempt be made to separate them, a slight force is required, which Stefan states, on further investigation, he is persuaded is simply the result of the resistance which the viscosity of the liquid or gas offers to its immediate inflow into the space between the two disks. The effect of this viscosity, of course, would disappear if the experiment could be performed in an absolute vacuum. On the other hand, the study of the experiments made by Stefan in the atmosphere at its ordinary pressure, and of such liquids as alcohol, water, solutions of salt, etc., has enabled him to determine the true co-efficient of viscosity or internal friction for these substances. The values he arrives at are, for water, 0.0108, for air, 0.00183; figures which agree exactly with those deduced by Maxwell and Meyer by entirely different methods of experiments. The actual separation by means of a slight force of the disks experimented with by Stefan is, he states, a dynamic, and not a static phenomenon. The time required in order to separate these plates through a given distance was inversely proportional to the force that was applied. It increased nearly as the inverse square of the original distance between the plates, and as the fourth power of the radius of the plates; and in whatever liquid he immersed his plates, the times were proportional to those required by equal volumes of these liquids to flow through capillary tubes.—19 *C*, VIII., 60.

THE DISSIPATION OF ENERGY.

In some remarks on the dissipation of energy, Lord Rayleigh states that the chemical bearings of this subject are very important. A chemical transformation is impossible if its occurrence involves the opposite of dissipation; but it is not true that a transformation which involves dissipation must necessarily take place; otherwise the existence of explosives, like gunpowder, would be impossible. The possibility of chemical action must often depend upon the density of the reacting substances. Thus, in the case of a mixture of oxygen and hydrogen in proper proportions at a certain density, the mixture may be exploded by an electric spark, and energy be dissipated; but beyond a certain point of rarity the explosion can not be made, as it could not then involve any dissipation. It may probably be found that many mixtures which show no tendency to explode under ordinary conditions, will become explosive when sufficiently condensed.

THE TRANSMISSION OF MECHANICAL POWER BY MEANS OF ELECTRICITY.

Magneto-electric machines have not yet attained that point of perfection which permits them to be placed among the industrial apparatus; but they at least offer a method of producing electricity very economically. The principal machines are those of Siemens and Halske, of the French Society of L'Alliance, and of Gramme. The currents produced in the last-named machines are analogous to those furnished by the galvanic battery, thus permitting its application to all works where voltaic electricity is useful. The Gramme, as adapted for electro-plating in the silver-works of Christoffle, of Paris, has a height of four feet and a length of two and a half feet, and the resulting electric current deposits eight hundred grammes of silver per hour, requiring a motive force of one horse-power. The experiments made at London by this machine give it the first rank among apparatus for producing electric light. A curious experiment was performed with one of these machines at the Exposition of Vienna. The principal magneto-electric machine being driven by an air-engine on the Lenoir system, the electricity thus produced was carried to the electro magnets of two Gramme machines of more feeble dimensions, which, acting as an electric motor, kept a small centrifugal pump in action. Thus the mechanical effect of the electricity was by the connecting wires carried to a great distance from the motor. The principal advantage of the transmission of force by electricity is found in the possibility of overcoming vertical spaces which are inaccessible to the cables or belts in use in manufacturing works. — *Bulletin Hebdomadaire*, XVI., 8.

CRYSTALLIZATION ILLUSTRATED BY THE MICROSCOPIC PHOTOGRAPH.

It is often very important in chemistry or in crystallography to be able to seize exactly the delicate forms of crystals, as examined by the microscope; but the most conscientious draughtsman can not always reproduce the fineness of these crystallizations. According to Girard, many crystals can be photographed. As a preliminary, it is necessary generally to dilute the solution to different degrees, and to allow one specimen of each kind of crystal to be formed by itself. We thus acquire the faculty of choosing that degree of concentration where the crystallographic characters are most appropriate to the methods of photography, either by reason of the delicate grouping of the forms, or by their transparency to the penetration of light. The most simple method of photographing the crystals consists in the use of an ordinary microscope, the body of which is placed in a horizontal position. In a dark room upon a table near a window the microscope is placed, and the object is illuminated by a beam of light coming through the window from a heliostat without. The luminous rays pass through the thin film of water containing the crystallized salt, traverse the objective of the microscope, and form a magnified image upon a distant screen. At the proper moment we substitute for the screen a sensitized photographic plate, and obtain a photograph by the ordinary processes. A number of pictures should be taken of the same object, in order to choose among them that which presents the nature of the crystalline system under the best conditions. This precaution is especially necessary in certain products, where the solution gives results distinct from each other, according to the degree of saturation.—13 *B*, III., 171.

EBULLITION PHENOMENA.

Dr. Phipson states that water strongly acidified with hydrochloric acid, and containing a small quantity of benzol, when placed over a spirit-lamp enters into a violent ebullition every sixty seconds. After a while the boiling ceases completely, and then recommences suddenly every thirty seconds, for a considerable period. The flask still being kept over the spirit-lamp, the periods between quiescence and violent ebullition dropped to twenty, ten, and finally to eight seconds, at which intervals the phenomena continued for a considerable time.

When methyl alcohol was added to the above mixture of water, hydrochloric acid, and benzol, and the flask placed over a spirit-lamp, no ebullition at all occurred for a long period of time, and then it took place suddenly and continued. —1 *A*, *April* 23, 177.

ON THE RELATION BETWEEN SPECIFIC GRAVITY AND MAGNETISM OF IRON.

From a number of experiments on the magnetism of iron and steel, Holtz concludes that galvano-plastic iron receives when made to glow by a galvanic current a greater specific gravity. The molecules are brought closer together, the intervals between them become smaller, and the permanent magnetic moment is diminished by one half. On the other hand, steel bars by being heated red-hot, and tempered, acquire a smaller specific gravity, the molecules are farther from each other than before, the intervals being greater, and the magnetic moment is notably increased. Again, Wiedeman has shown that permanent magnetism is diminished by torsion, but temporary magnetism increases by detorsion. These effects can be explained by the same relation above found between density and the magnetic force of iron. The torsion increases the density of the iron, and the magnetism must therefore diminish. By detorsion, the molecules of the magnets are separated from each other, and the magnetism itself increases. It can, then, be assumed as probable that the magnetic forces in general are functions of the spaces between the molecules, and dependent upon the dimensions of these spaces.—19 *C*, VIII., 151.

RELATIONS BETWEEN CHEMISTRY AND THERMOTICS.

The study of the evolution of heat in chemical combinations is a new branch of science, belonging partly to physics and partly to chemistry, and the number of facts already observed is sufficiently numerous to indicate certain laws which are set forth by Berthelot. He premises that in the act of producing any chemical change, the molecules hit sharply against one another, and give off heat, just as when a hammer strikes a bar of iron. From the study of the relations between the amount of heat and the amount of work done, it is possible to establish some theorems of thermochemistry.—12 *A*, X., 473.

RELATIONS OF HEAT AND ELECTRICITY.

In a very suggestive article of Kohlrausch on thermoelectricity, he develops the hypothesis that currents of heat and of electricity are connected together in every conductor of heat, the heat being moved by an electric current whose heat-moving force is proportional to the electro-motive force of the heat current in the same body.—12 *A*, X., 278.

CONTINUITY OF THE LIQUID AND GASEOUS STATES OF MATTER.

Professor Andrews, of Belfast, at the meeting of the British Association in 1874, made a further communication on the continuity of the liquid and gaseous states of matter. As the result of some of his more recent investigations, he stated that the compressibility of sulphurous liquids, unlike that of water, diminishes as the pressure increases. A mixture of three volumes of carbonic acid and four of nitrogen was subjected to a pressure of 300 atmospheres at various temperatures, from 2° to 48° C., with the very important result that, even at 2°, the carbonic acid of such a mixture could not be liquefied under any pressure. Indeed, the "critical point" of carbonic acid proves to be lowered many degrees when that gas is mixed with a non-liquefiable gas, such as nitrogen.—15 *A*, *Aug.* 29, 1874, 277.

THE FORCES DEVELOPED BY EVAPORATION AND CONDENSATION.

Professor Osborne Reynolds, in a careful review of the remarkable observations recently made by Mr. Crookes, shows that, according to the kinetic theory of gases, whenever a molecule of liquid is evaporated, and becomes a molecule of gas, it must leave the liquid surface with a velocity equal to that with which the other particles of the gas are rebounding among themselves; that is to say, instead of being first detached, it must be shot off with a velocity greater than that of a cannon-ball, and there must be an equal reaction on the surface of the remaining liquid; the contrary effect takes place in the case of condensation. Applying the necessary mathematical formulæ, he finds that, at a temperature of 60°, the evaporation of one pound of water from a surface is sufficient to maintain a force of 65 foot-pounds for one second, the force being proportional to the square root of the absolute temperature. In the case of mercury the force is only 6 foot pounds instead of 65. And again, whenever heat is communicated from a hot solid surface to a gas, an effect similar to that of evaporation is produced, while for every English unit of heat communicated to steam, at a temperature of 60°, the reaction on the surface is equivalent to 0.38 of a pound acting for one second; but is, for air, 0.55 of a pound.—12 *A*, X., 175.

THE HEAT PRODUCED BY GALVANIC CURRENTS.

Since the galvanic effect upon metal wires, by means of which they are made to glow, has acquired a practical importance in galvano-caustics, it appears desirable to present, in the clearest manner, the connection between the power of the battery, the dimensions of the wire, and the resulting phenomenon; and the first attempt at a partial solution of this problem appears to be due to Professor Müller, of Freiburg. According to him, we obtain a measure of the intensity of the glow by dividing the intensity of the galvanic current by the diameter of the wire; the current intensity being given by Ohm's law, we of course find that the effect will depend upon the number of elements in the galvanic battery, and the electro-motive force of each element; also upon the resistance of the wire and the battery. For the same battery acting on the same length of wire a maximum glow will be produced when the wire has a certain determinable diameter, and the intensity of the glow diminishes when the wire is either thicker or thinner than this. For instance, with six of Ruhmkorff's zinc and carbon elements acting on a platinum wire one decimeter long, the maximum glow is produced when the diameter of the wire is ⅓ of a millimeter; for a wire two decimeters long the thickness must be $\frac{1}{10}$ of a millimeter to produce the maximum effect. With a battery of two of Stohrer's elements a platinum wire, two decimeters long, can not be raised to a white-hot glow, but may be raised to a red heat when its diameter is 1½ millimeters, or less. Again, in order to make red hot a platinum wire of ½ millimeter diameter and two meters long, a battery of 28 elements is necessary, while 40 such will not make this wire white hot.—*Berichte d. Naturf. Gesell. Freiburg*, VI., 2, 97.

THE MOLECULAR CONSTITUTION OF GASES AND LIQUIDS.

That the same substance at the same temperature and pressure can exist in two very different states, viz., as a liquid and as a gas, is a fact of the highest scientific importance, for it is by the careful study of the difference between these two states and the phenomena which occur at the surface which separates the liquid from its vapor that we may expect to obtain a dynamical theory of liquids. A dynamical theory of perfect gases is already in existence; that is to say, we can explain many properties of gaseous bodies by supposing their molecules to be in rapid motion, and that they act on one another only when they come very near or strike each other; but we can not extend this dynamic theory from the rarer to the denser condition obtained by subjecting the gas to great pressure without at the same time obtaining some definite conception of the nature of the action that takes place between molecules when they are only for an instant in close contact, which action, in fact, depends upon the particular constitution of the encountering molecules. The first contribution to a dynamic theory of liquids is made by Maxwell in some comments on the labors of Vanderwaals, where he takes occasion to show that we have evidence that the molecules of gases, besides encountering each other in their motions, also attract each other at a certain small distance, but when they are brought still nearer they repel each other, a conclusion in accordance with Boscovich's theory of atoms. On the other hand, the molecules of liquids, or even these same gaseous molecules, when reduced to the liquid condition, apparently repel each other at a certain small distance, which repulsive forces between contiguous molecules are overcome by the general attractions of the mass of the body.—12 *A*, X., 479.

ON THE REFLECTION OF SOUND FROM A LAYER OF FLAME OR HEATED GAS.

Mr. Cottrell has observed the reflection of sound from a coal-gas flame in the following manner: Sonorous pulses sent through an open tube agitate a sensitive flame placed at its other end; but when a coal-gas flame is placed between the end of the tube and the flame, the latter is no longer affected by the sound sent through the former. He then placed two tubes so that they were equally inclined to one face of the gas flame, and, sending the sound into one of these tubes, it was reflected from the flame, passed up the other tube, and agitated a sensitive flame placed at its mouth. In a similar manner he has shown that part of the sound is reflected from the flame, and part is transmitted by the flame, thus giving a complete analogy between the reflection of sound from a flame and the reflection of light from a transparent plate. He obtained the same effects, as given above, when he replaced the flame by the sheet of heated gases rising from it.

THE EVAPORATION OF METALS BY ELECTRICITY.

Mr. Hopkins describes an interesting experiment, which consists in passing a charge of electricity through a very fine thread of platinum, or other metallic foil, the thread being kept in place between slides of microscope glass. The effect of the heat from the electric discharge is to vaporize the metal, which is instantly condensed in a transparent layer upon the cold glass, which can then be studied by the microscope, and can be used in various ways to determine the character of the metal and the peculiarities of the discharge.—12 *A*, X., 190.

STEAM FOG-WHISTLES.

It has been found by General Duane, of the United States Engineers, in his experiments made to determine the best form of boilers for steam fog-signals, that as the steam used is at a high pressure, and is drawn off at intervals, there is a constant tendency to foam and throw out water with the steam. To counteract this, a horizontal tubular boiler, like those used in locomotives, is recommended by him. The steam-dome must be very large, and surmounted by a steam-pipe 12 inches in diameter. The steam should be drawn off at a point ten feet above the water level in the boiler. The diameter of the boiler whistle should be two thirds of its length, and the vertical distance of its lower edge above the coping, for a steam pressure of 50 pounds, should be from one third to one fourth of the diameter.—*Elliot's European Light-house System*, p. 25.

THE GAS GUN FOR FOG-SIGNALS.

A very ingenious application has been made, by Mr. Wigham, of the explosive nature of a mixture of ordinary gas in air. He establishes at any point on the coast where a fog-signal is desired a gas gun. It is simply a tube of iron, connected with the gas-holder by the proper pipe; the holder, of course, may be at any convenient distance. The gas-holder is filled with a mixture of one fourth air, and the remainder coal-gas and oxygen, and this mixture is allowed to flow into the gas gun, when it may be fired off by touching a match to the proper orifice, taking care, of course, to close all communication with the holder. By using an electric spark, instead of the match, the service of the gun may be made still easier. The flash from this gun is said to illuminate the fog much better than that from a discharge of gunpowder.—*Elliot's European Light-house System*, p. 74.

A NEW FOG-SIGNAL.

Experiments made in England with gun-cotton in the open air are said to have demonstrated that a mass of ten ounces of compressed gun-cotton, fired by means of two ounces of dry gun-cotton, as a primer, the whole being detonated with fulminate of mercury, produced a discharge which could be heard very distinctly at a distance of ten miles in all directions. These results were so satisfactory that it has been determined to build a parabolic reflector of cast iron, by which the intensity of the sound of the explosion of a charge of compressed cotton placed in its focus will be greatly intensified in one direction. The trials of the adaptability of this device as a fog-signal will be made at the Royal Arsenal, Woolwich.—*The Engineer.*

NEW METHOD OF OBSERVING THE VIBRATIONS OF A TUNING-FORK.

A new method of determining the absolute number of vibrations corresponding to any musical note is described by Poske, and has a high value in comparison with those that have hitherto been employed, which may be classified as graphic, acoustic, and optic: the first of these three is comparatively rough; the use of the siren is a good example of the acoustic method, although its practicable employment is found troublesome; and of the optical, that of Lissajous is in high esteem. The new method proposed by Poske consists, first, in replacing the clock or chronometer by the electro-magnetic rotation apparatus of Helmholtz, whose velocity of rotation is extremely constant, and can be determined accurately to its ten-thousandth part. The essential portion of this apparatus consists in a centrifugal regulator, which diminishes the strength of the electric current by the diminution of the number of contacts, as soon as the velocity of rotation exceeds a certain limit. The observer examines, through a microscope, a minute bright point upon the vibrating rod or cord, which point by its vibrations appears as a bright line; and between the eye and the vibrating point there also rotates a disk perforated with a known number of slits. The combination of the revolving slits and the vibrating point causes the latter to appear to move slowly to and fro, in periods similar to the acoustic phenomena known as "beats." It is evident that the number of vibrations of the point is determined by the velocity of rotation, the number of slits, and the duration of the beats, the accuracy of the method being very great.

In the application of his method of determining the time of vibration of a tuning-fork, Poske has also been able to show that the vibrations of the latter vary with the amplitude of the arc of vibration; that the durations diminish in a geometrical series as the amplitudes diminish; and that, in general, the change in duration is proportional to the first power of the amplitude, and not, as in the pendulum, in proportion to the square of the amplitude.—*Poggendorff Annalen*, CLII., 463.

THE ACTION OF ORGAN-PIPES.

Mr. Hermann Smith states as the result of experimental studies that within an organ-pipe the "air reed" vibrates in arcs whose extent diminishes as we increase the speed of the reed, or that the times vary with the amplitude; and to this he adds the remarkable feature that the motion of vibration is an activity tempered by rests, and that the note of every open organ-pipe is not single, but a concord of two tones.—12 *A*, X., 162.

EFFECT ON SOUND AND LIGHT OF THE MOVEMENT OF THE OBSERVER.

The long-vexed question as to the effect, upon observations, of the movement of the observer, and the source of light or sound, has been elucidated by Baron. Eotvos, of Pesth, who, in a recent communication, extends his former investigations, and offers a satisfactory refutation of several objections that have been raised. According to him, in case the source of sound or light be moving, the intensity must be defined as the living force that would fall, in a unit of time, upon a unit of surface, parallel to the wave surface, if all vibrations were like those which are imparted to the surface at that instant in which the intensity is to be determined. The formula for the intensity in question, as deduced by Eotvos, shows that the movement of the observer has a decided effect upon the result; and by applying this to the case of an observer moving upon a locomotive, with a velocity of a hundred feet per second, and listening to a sound whose origin moves at the same rate toward him, he finds the observed sound 0.8 times as loud as when both are at rest. A method is also explained by him, showing the possibility of testing his conclusions by experiments on the heat received and sent by moving bodies.—*Poggendorff Annalen*, CLII., 535.

THE THEORY OF RESONATORS.

Lord Rayleigh contributes an extract from a forthcoming work by himself on acoustics, in which he submits a new theory of the action of resonators, and opposes emphatically the general statement that a resonator augments the body of sound by offering a column of air which is capable of vibrating in unison with the original sounding body. The exceptions to this rule, he thinks, are very important in a theoretical point of view; and he prefers to reverse the statement, and to say that the neighborhood of a resonator in unison with a sounding body diminishes the loudness of the latter. The resonator, in fact, instead of augmenting the effect of a source of sound, annuls it altogether, so far as external space is concerned, by absorbing the condensations and rarefactions into itself.—*Phil. Magazine*, p. 419.

VIBRATION OF MEMBRANES.

In a paper read before the London Mathematical Society, Lord Rayleigh demonstrates the theorem that an increase in the dimensions of a vibrating system is attended by a rise in pitch. For instance, if the system consists of a uniformly stretched membrane, with a fixed edge, it follows that any contraction of the boundaries must cause an elevation of pitch. If the membrane be uniform, of given density and given tension, the frequency of vibration is a function of the size and form; and if the form is invariable, the frequency varies as the linear dimension. The pitch of the vibrations of a regular polygon is intermediate between those of the inscribed and circumscribed circles. When the area of the membrane is given, it is easy to see that any projecting corners tend to raise the pitch, thus among rectangles of a given area the square gives the gravest tone, and any membrane not a circle is higher in pitch than the circle of equal area. In estimating therefore the lower limit to the pitch of a regular polygon, it is best to substitute for it a circle of equal area.—*Proc. London Mathematical Society*, V., 9.

THE SPECTRA OF THE LEAST FUSIBLE METALS.

Messrs. Lockyer and Roberts have attempted to investigate the nature of the absorption spectra of the least fusible metals, for which purpose they employed the oxyhydrogen blowpipe to volatilize the substances. Their experiments, conducted at these high temperatures upon more than twenty metals, go far, they think, to support the conclusions which they had previously drawn from experiments at a lower temperature on more easily volatilized metals, viz., that in passing from a liquid to the most perfect gaseous state, vapors are composed of molecules of different orders of complexity, and that this complexity is diminished by the disassociating action of heat, each molecular simplification being marked by a distinct spectrum.

THE CAUSE OF THE VARIATION OF GASEOUS SPECTRA.

The variations in the spectra of gases have been usually supposed to depend to a certain extent upon the temperature at which the light is produced. Wüllner has advanced the theory that the spectrum depends upon the nature of the electric spark; but Goldstein has recently advanced opposite views, to the effect that the different order of spectra are entirely independent of the form of the electric discharge by which the light is produced. He states that he has been able to secure a notable increase in the width of the lines of the spectrum of hydrogen when the pressure has been less than one one-hundredth part of a millimeter. His experiments lead him to think that any given order of spectrum can be produced, if we only have a sufficiently high temperature.—19 *C*, VII., 444.

A SIMPLE SPECTROSCOPE FOR STARS.

For the purpose of observing the spectrum of stars or other points of light, Zöllner describes a very compendious instrument to be used in combination with the eye-piece of a telescope. He introduces between the ordinary eye-piece and the eye of the observer a small tube containing a cylindrical convex lens of about four inches' focal length, for which lens, under different circumstances, we may substitute other lenses of different lengths of focus. Within the tube containing this lens, and between it and the eye, there is inserted a second tube holding an ordinary direct-vision prism, such as is made by Browning. The intensity of light in this ocular spectroscope is so considerable that in combination with a small portable telescope of one and a half inches' aperture it shows distinctly the lines of stars of the first magnitude, and of the crescent of Venus. It is peculiarly applicable to the systematic observation of star spectra in which the main object is to ascertain the typical constitution of the spectra.—7 *A*, XLVIII., 156.

THE BEGINNINGS OF SPECTRUM ANALYSIS.

According to Lockyer, the distinguished Swedish philosopher Angström, whose untimely death in June, 1874, was at the time chronicled by us, will be forever considered as the founder of spectrum analysis, although unfortunately the obstacles opposed by the language in which his first treatise was written, and by distance from the scenes of his investigations, for three years prevented even its existence from being known to the scientific world at large. His work, "Optiska Undersokningar," published at Stockholm in 1853, was the first publication in which use was made of a principle already propounded by Euler, viz., that the particles of a body in consequence of resonance absorb principally those æthereal undulating motions which are impressed upon them. He also endeavored to show that a body heated until it glows emits the same kind of light and heat which it absorbs under other circumstances; he further stated that in many cases the Fraunhofer lines are the inversion of the bright lines which are observed in the spectra of various metals in the galvanic arch.—12 *A*, X., 377.

SPECTRA OF CERTAIN RARER METALS.

Professor Thalen has published the result of an investigation into the spectra of the rarer metals yttrium, erbium, didymium, and lanthanium. He has operated with large quantities of the metals of undoubted purity, and his results are the most reliable hitherto obtained. He has not only removed all doubt with regard to some 28 spectral lines that were hitherto known, but has increased the whole number of these lines peculiar to these metals from 160 to 590.

EFFECT OF TEMPERATURE AND PRESSURE ON THE SPECTRUM LINES.

The question has often been discussed whether it is temperature or pressure which causes the widening of the lines in the spectrum of any gas. The following considerations are adduced by Schuster as favoring the view that each separate molecule would show at all temperatures narrow lines only, but that the shocks of the other molecules cause the widening, which may therefore be considered as depending rather upon pressure than temperature. Frankland and Lockyer have found that if we increase the pressure of hydrogen while the electric current is passing through it, the lines begin to expand until the spectrum becomes continuous, and, finally, the current ceases to pass altogether. On the other hand, Gassiot has observed that if we diminish the pressure of hydrogen, its electric resistance diminishes, becomes a minimum, and then increases again. We are therefore compelled to accept Frankland and Lockyer's original conclusion that pressure and not heat is the cause of the widening of the line.—*Rep. Brit. Assoc.*, 1873, 39.

NEW TABLES OF SPECTRUM LINES.

The committee appointed by the British Association to construct a catalogue of spectral rays state in their recent report that the whole of their work is now finished and ready for the printer, so far as regards the solar spectrum, while the positions of the metallic lines, as determined by Thalen, have been only partly reduced to uniformity with the rest of the work. The tables presented by them are constructed by throwing the solar lines into those groups which catch the eye in observing the spectrum, and the position of each line has been corrected for the dispersion of air. Both Kirchhoff's and Angström's scales will be given with the adopted wave-lengths for each spectral line, so that it is hoped that, when these catalogues are printed, observers will find in them, in a collected form, the best materials which yet exist for the identification of lines, and for the reduction of fresh determinations to wave-lengths.—*Rep. Brit. Assoc.*, 1873, 250.

ADVANTAGEOUS CONSTRUCTION OF THE SPECTROSCOPE.

In some remarks upon the optics of the spectroscope, Mr. Sorby states that in the construction of a spectroscope the eye-piece should be of as long a focus as possible, so as to cause all the rays to enter the eye. All magnifying beyond this means loss of brilliancy; and if the spectrum appears insufficiently large, an increase in the size of the collimating and telescope lenses, together with the prisms, or an increase in the number of prisms, should be made, until the spectrum appears large enough to suit the requirements of the observer.—12 *A*, X., 469.

ABBE'S REFRACTOMETER.

The new instrument devised lately by Professor E. Abbe, of Jena, for the determination of the index of refraction of any transparent body, has received high encomiums, and promises to be of use in all optical researches. In principle it is, we understand, based upon the property of total reflection of light. Two similar right-angled prisms are so fixed that their hypothenuses are parallel and a slight distance apart. Between them is placed the liquid to be examined, and by measuring the angle through which this combination must be turned in order to secure the total reflection of a ray of light, we have the means of directly determining the index of refraction. In order to employ white light, and annul the indistinctness caused by the dispersion of light, a compensator is introduced, based upon a combination of flint and ground-glass prisms, and it is stated by Professor Waltenhofer that the execution of measurements with this instrument leaves nothing to be desired as regards rapidity, elegance, and accuracy.—*Technische Blätter*, 1874, 106.

THE CAUSE OF THE LUMINOSITY AND NON-LUMINOSITY OF FLAMES.

It has been ascertained that if nitrogen, hydrochloric acid, or carbon dioxide be passed into the flame of a Bunsen burner, it becomes non-luminous; but when any such mixture becomes strongly heated before it undergoes combustion it again becomes luminous.

From these observations it may be concluded that the non-luminosity of a gas flame is not caused by a dilution of the gas, this dilution being in fact increased by heating the mixture. The only cause is the cooling of the interior of the flame. This is further proved by the fact that it is most difficult to get a non-luminous flame from a mixture of coal-gas and oxygen, showing that neither rapid oxidation nor dilution produces the non-luminosity. — 21 *A*, *July*, 603.

FLAME OF BURNING GLYCERINE.

According to Godeffroy, glycerine burns with a steady blue non-luminous flame, without diffusing any odor or leaving any residue.—17 *A*, *June* 1, 84.

A PERFECTLY MONOCHROMATIC SODIUM FLAME.

Laurent recommends the following simple method for rendering the light proceeding from a soda flame, which it is desired to use for saccharometric and similar work, perfectly monochromatic. Between the flame and the polarizer he interposes a thin lamina of potassium bichromate, which possesses the property of absorbing the violet, blue, and green rays contained in the sodium flame, the presence of which impairs the accuracy of observations involving a comparison or determination of the equality of tints.—2 *C*, III., 1875, 62.

AN APPARATUS FOR ILLUSTRATING THE MECHANICAL EFFECTS OF LIGHT.

Dr. William Crookes is the first to illustrate by experiment the production of direct mechanical effects by the action of luminous rays. The apparatus, with the aid of which the demonstration was made, and to which its designer gives the name of the radiometer, is described as follows: The radiometer consists of four small pith disks, fixed at the extremities of two crossed arms of straw, balanced on a pivot at the point where the straws intersect, so that they may freely spin round. These pith disks are white on one side and blackened with lampblack on the other, and the entire arrangement is inclosed in a glass bulb from which the air has been removed with the help of a Sprengel pump. With an apparatus of this description, the disks and arms spun around rapidly when luminous rays were directed upon it, but obscure heat rays produced no effect upon it. When submitted to the action of light from which 95 per cent. of the heating rays had been cut out by the interposition of a plate of alum, the disks still revolved, though with somewhat diminished velocity. Contrary to expectation, it was the blackened faces of the disks that were repelled by the light.

THE SPECTROSCOPE WITH A FLUORESCENT OCULAR.

In observing the most refrangible portions of the spectrum it is common to use two methods—either the spectrum falls upon a plate sensitive to the ultra violet rays, or else the spectrum falls upon a fluorescent substance which has the property of revealing these rays. To this a third method is now added by Soret, whose application is very simple. Soret's method consists in this, that he inserts a plate of transparent fluorescent substance in the tube of the spectroscope, and observes the spectrum with a telescope whose ocular is inclined to its axis. With a plate of uranium glass the fluorescent spectrum is well seen. The best substance, however, is a somewhat concentrated solution of *aesculin*, by means of which the spectrum may be traced up to the line O. This simple apparatus affords an especially convenient method for examining the spectrum of the ultra violet portion of the solar light.—19 *C*, VII., 232.

ON THE INTENSITY OF THE LIGHT REFLECTED FROM GLASS.

Dr. Glau states that hitherto the investigations of the properties of reflected light have, by preference, referred to the ratio of the two principal components to each other, as well in respect to their phases as to their intensity; and in but few cases has it been attempted to make a direct comparison of these two components in regard to the incident light. The only experiments on the intensity are found in Arago's works, and are quite fragmentary, and on that account the inquiry has been undertaken anew by Dr. Glan, in order especially to test the accuracy of Cauchy's formula. His observations give the ratio of the intensity of the reflected light to the incident light for two prisms, one of crown and one of flint glass. A comparison with Fresnel's formula, which is identical with Cauchy's, shows that the differences between observation and theory fall quite within the range of errors of observation.—7 *A*, XLVIII., 478.

THE FIXED STARS AS VISIBLE THROUGH MINUTE APERTURES.

In a recent letter to the English *Mechanic*, Mr. Allen endeavors to contribute somewhat to the understanding of the phenomena of the black drop, by considering the question of the visibility of the stars through minute apertures. He states that the stars are not seen ordinarily on a clear night as simply intensely bright and vivid spots on a dark background without rays or bright surrounding burrs, but generally accompanied by three or four or more rays darting out of the bright burr. The question as to whether these phenomena are caused by interference or by the atmosphere, or whether they are purely subjective, can perhaps be decided by viewing the stars through minute needle-point holes in a thin opaque plate. If through such a minute hole we look at a dull, white, cloudy sky, we see not only the dull hue of the sky, but also a thin, gauze-like covering as of lace hanging between the opaque plate and the sky. When the hole is comparatively large the edges of the field of view only are covered by this gauze veil, while when the hole is exceedingly small the effect is intensified by the closing in of the veil on all sides, so that the field of view is completely filled up with an almost black gauze which can only be seen through darkly. On viewing the stars through such a minute hole, it will be found that the rays ordinarily darting from the star totally disappear, not only the longer rays, but also the shorter ones forming the bright burr, and the star appears like a planet, showing a clearly defined disk with a somewhat fainter light, in the centre of which a minute black point is distinguished. Viewed in this way the star still twinkles, and has still the color and the changes of color as ordinarily seen. If now two needle-holes be made near together, perhaps $\frac{3}{16}$ of an inch apart, then the two images of the star will be seen apparently touching each other, with a black spot at their point of tangency.—18 *A*, XX., 5.

THE OPACITY OF PHOTOGRAPHIC IMAGES.

In a series of pictures of the sun which have lately been taken by photography, Captain Abney states that he finds the opacity of the image by no means to vary directly as the time of exposure. Having obtained a standard gradation of intensity of light by causing a starlike aperture to revolve rapidly around its centre, he determined the relative opacities of the images by comparison with smoke-colored glass wedges, and he finds that the degree of opacity after diminishing very rapidly in the first moments of exposure, then diminishes very much slower, and nearly proportional to the time. The images given on dry places are in general somewhat more opaque than those given by weighty plates, especially during the first moment of the exposure.—7 *A*, XLVIII., 164.

ON WAVE SURFACES IN OPTICS.

Cellérier has in a note on the optical properties of elastic media shown in brief that there is no discord between the laws of double refraction as furnished by observation and by theories based upon molecular movements. It is probable that the ordinary ray, either in the crystals of one axis or in the principal sections of the crystals of two axes, has not always the direction that is ordinarily assigned to it. This deviation, however, without being discordant from theory, may be so small as to escape observation. Finally, renouncing all mechanical explanation of the phenomena, it is necessary to admit that the direction of the vibrations is parallel to the plane of polarization, and therein is a decided confirmation of the theory. There is, in fact, at present not any other new hypothesis necessary in order to show the coincidence between theory and observation.—*Biblioth. Univers., January*, 1874, 23.

ELLIPTIC POLARIZATIONS OF LIGHT.

The nature of the light reflected by potassium permanganate has been investigated by Dr. Wiedemann, who has examined the reflected light both by the spectroscope and the polariscope. The crystals of the above-mentioned substance were polished upon ground-glass plates, thus giving clean surfaces free from oxides. The positions of the lines in the spectrum were determined by reference to a photographed scale, and it was found that with large angles of incidence the lines in light polarized perpendicular to the plane of incidence were displaced toward the blue end of the spectrum, as compared with those lines that occur in light polarized parallel to the plane of incidence. Again, in the former light a new line occurs in the vicinity of the line D. With an increase in the index of refraction of the surrounding medium, the lines in the parallel polarized light undergo displacement toward the blue, while those in the perpendicular polarized light alter their positions but very little. In the light polarized parallel to the plane of incidence, as also in natural light, the positions of the lines did not vary with the angle of incidence, while they do vary in perpendicularly polarized light.—7 *A*, XLVIII., 232.

A NEW CLASS OF ABSORPTION PHENOMENA.

A late number of the memoirs of the Spectroscopic Society of Italy contains a contribution by Lockyer to the spectroscopic investigation of the absorption phenomena. These phenomena consist in observing the absorption produced by vapors of sodium and potassium heated in a red-hot tube through which a beam of sunlight passes. Lockyer states that the Fraunhofer line D becomes broader on one side; and again, in reference to the general question of the absorption of great thicknesses of metallic vapors, he states that metallic elements of low specific gravity give spectra approaching in their appearance a continuous spectrum by increasing the number of their lines.—*Memoirs of the Italian Spectroscopic Society*, 1874, 97.

THE PHOSPHORESCENCE OF PHOSPHORUS.

From the doctorate dissertation of Joubert, of Paris, we gather that he has definitely settled the question as to the origin of the phosphorescent light of phosphorus by demonstrating that it is really due entirely and only to the slow oxidation of that substance. Among the numerous results of his unusually thorough and suggestive work, we note that in pure oxygen the temperature at which phosphorescence takes place depends on the pressure of the gas; and in diluted oxygen the law is quite different. The elastic force of the vapor of phosphorus is 0.5 millimeters at a temperature of 5° Centigrade, but is 6.8 millimeters at a temperature of 40° Centigrade. In absolute vacuum, or in pure inert gases, no phosphorescence takes place.—8 *B*, *July* 25, 1874, 87.

ON OPTICAL PHENOMENA AT THE TRANSIT OF VENUS.

Mouchez states in reference to the observations of the black drop, as it appeared to the French observers at the island of Saint Paul in the Southern Pacific Ocean, that in proportion as Venus entered upon the sun's disk the clouds became thinner, the heavens more transparent, and images of great precision. A quarter of an hour after the first contact, while half of the planet was still beyond the limit of the sun, suddenly the whole disk of Venus was perceived shining like a pale circle, more brilliant in the neighborhood of the centre than at the outer edges of the planet. The diameter of the planet was immediately measured with the micrometer, and found to be identical in all directions through its centre, showing that the disk was real, and not an optical deception. But in proportion as the second contact approached the two brighter portions in the neighborhood of the centre tended to unite themselves into an enveloping circle of bright light around the segment of the planet which was still exterior to the sun. And this anticipated reunion of the horns by a luminous circular arc was rendered more complete still by a small, very brilliant flange of light terminating the aureole on the disk of Venus. Foreseeing that there would be very great difficulty, if not impossibility, in observing the geometrical second contact, the observer changed quickly the pale blue colored glass for a darker one, by the aid of which he hoped to avoid this aureole, and these accidental glimmerings. But this was useless; the aureole remained always visible, and he was obliged to return to the original lighter-colored glass. Under these conditions, he took as the moment of contact, not the reunion of the two horns or the geometrical contact, but rather the moment when the disk of the sun seemed no longer to be deformed by the brilliant light which enveloped the planet at the point of contact. He noted a very sensible difference of time between the instant when he thought that this contact had taken place, and that when he was certain that it was past.—*Bulletin Hebdomadaire*, XVI., 21.

ON THE PHENOMENA OF DIFFRACTION PRODUCED BY CIRCULAR NET-WORK.

Soret states that he gives the name of circular net-work to opaque screens pierced by a series of apertures presenting the form of concentric rings. When a beam of light falls upon such a net-work, phenomena of diffraction are produced varying according to the relations which exist between the diameters and the breadths of the rings. Some very remarkable phenomena have been observed by him, which seem to verify the theoretical considerations that he has advanced in reference to this subject. The screens experimented upon by himself were obtained by making a design in china ink in the form of 196 concentric circles, whose radii were proportional to the square roots of the natural numbers 1, 2, 3, etc. The first circle had a radius of 25 millimeters. The greatest, consequently, had a radius of 350 millimeters. The rings comprised between the first and second, between the third and fourth, etc., were blackened. We thus have in white upon black background the figure of a grand positive circular network, having 96 concentric rings. This design was reproduced by photography upon glass, in various scales of from one one-hundredth to one twenty-fifth of the size of the original. A beam of solar light is now introduced into a dark chamber by an opening of any form whatever, and we place a red glass before this opening, thus giving nearly homogeneous light. Then at a proper distance a collimating lens, which renders the rays parallel, and gives at a great distance at the end of a large hall an enlarged image of the opening. Behind the collimating lens we place the circular net-work formed as previously described, the image at the end of the hall continues, only it is a little less clear, and is surrounded by an aureole, which we may attribute to the imperfection of the net-work. If now we place a white screen at the proper distance, we shall obtain a new image of the opening, smaller but distinct. But outside of this image the screen is also illuminated, as it should be, to accord with the theory. Bringing the screen into the second proper position, we observe a still smaller image, scarcely visible, in fact, with the one twenty-fifth screen in which the proportion of light and darkness is well marked, being better marked with the finer screens. In the intermediate distances we have upon our screen no image, but simply a luminous spot. If we repeat this experiment with white light, we find the circular net acting like a non-achromatic and very dispersive lens. At the distance proper for the red rays, the image is red, surrounded by a blue aureole. On removing the screen further, the image changes through the yellow and the green, and finally becomes blue; having in the latter case a red aureole. From this latter experiment Soret shows that we can consider the little circular screens as concave lenses, so that the ordinary Galilean telescope may be constructed by employing such a screen instead of the eye-glass.—*Bull. Hebdom.*, XVI., 71.

THE COLOR OF DIAMONDS.

Flight and Maskelyne have lately made some curious observations upon colored diamonds. It has for some time been known that the tints of these stones are either destroyed or modified by heating, the change being sometimes temporary, sometimes permanent. In the present case two yellowish diamonds from the Cape of Good Hope were strongly heated in an atmosphere of hydrogen in a porcelain tube, for about two hours. Upon cooling, the color of the stones was found to have vanished, but it returned after exposure, for only a few minutes, to diffused light. In one instance a diamond which had been decolorized by heat was kept in the dark for three days, and remained colorless; but an exposure of six or seven minutes to the light again brought back its yellowish hue. These facts appear to stand in some relation to phenomena of phosphorescence.—15 *C*, XXIX., 33.

GILT GLASS PRISM IN THE CONSTRUCTION OF THE CAMERA-LUCIDA.

By taking advantage of the property possessed by thin metallic films of allowing the passage of direct rays through them, while they reflect oblique rays from some other source, Professor Govi, of Rome, has devised a perfect method for superposing a direct and reflected image, as is necessary in the camera-lucida, without the usual fatigue to the eye. He simply gilds the reflecting surface of the prism, in the camera-lucida, with a very thin film of gold, and, with Canada balsam, cements to this surface another similar prism. The reflected image appears of the usual yellow color of gold by reflected light, while the transmitted one is green, a difference that is not only not annoying, but in some cases serviceable. The suggestion of Professor Govi has been adopted by Nachet in the construction of various forms of camera-lucida.—14 *C*, CCXIII., 1874, 447.

COMPRESSIBILITY OF WATER.

Mascart has shown that the compressibility of water varies more rapidly than the pressure, as has already been observed for other liquids. The methods used by him to investigate the subject have also induced him to measure the heat evolved by the compression of water; or, rather, the lowering of temperature when the pressure is suddenly removed.—4 *D*, VII., 593.

NEW PHOTOMETERS.

Major Elliot reports that in his visit to the establishment of Messrs. Chance, at Birmingham, the scientific director in charge, Dr. Hopkinson, presented him with a photometer of his own invention for the comparison of lights at a distance. It is very compact, and consists of two Nicol prisms which can be moved relatively to each other in azimuth. A little tube carries the analyzing prism, and a second tube contains the polarizing prism. The latter being turned until the observed light is just diminished to the point of invisibility, and another light being then observed in the same way, a comparison of the angles gives the relations of the powers of the lights. The French Light-house Commission employ a photometer different from Bunsen's, as ordinarily used in America, in which, instead of keeping both the standard light and the one under test fixed in position, the former is moved until the beams from both, after passing through a slit or opening in the photometer, fall upon a pane of glass which has a ground surface, and which, as viewed on the reverse side, seems equally illuminated by the two lights. The distances from the photometer are then measured by a tape line, and reference to a calculated table shows at once the intensity of the light under test, in terms of the standard, or unit, which in France is always the Carcel burner, consuming forty grammes of colza oil. This French unit is estimated to be equal to between nine and a half and eleven and a half of the English units or candles.—*Elliot's European Lighthouse System*, p. 183.

THE REFLECTION OF LIGHT.

An almost exhaustive historical essay, by Lundquist, on the investigations of earlier physicists into the peculiarities of the light reflected from the surfaces of solid bodies, is supplemented by observations made by himself on the reflection from fuchsin and some other substances. The methods followed by him were similar to those adopted of late years by Jamin, Wiedemann, Van der Willigen, and others. A narrow pencil of sunlight, reflected in a fixed horizontal direction from a heliostat, passes successively through an achromatic lens, a flint-glass prism, and a polarizing Nicol's prism, and falls upon the reflecting surface of fuchsin; the reflected light is then analyzed by a compensator and a second Nicol's prism. Rays of light from seven different portions of the spectrum were examined; and Lundquist concludes that, in respect to the principal angle of incidence, fuchsin comports itself as does indigo, and the observations are represented by the theoretical formulæ for metallic reflection so long as the angle of incidence is greater than 50°. The author's investigation into the intensity of the reflected light shows that, on the one hand, the intensity is always slightly less than that computed, and that, on the other hand, the quantities reflected vary sensibly with the color of the incident light, so that when white light falls upon the fuchsin the color of the reflected rays varies with the angle of incidence. The power of the substance to absorb different colored rays offers a remarkable anomaly, as, while the yellow light is reflected in greater proportion than the blue, it is absorbed in less proportion.—*Poggendorff Annalen*, CLII., 595.

THE ACTION OF LIGHT UPON CHLOROPHYLL.

It has been long known that alcoholic extracts of chlorophyll are decomposed rapidly in the sunlight, but slowly in diffused daylight, and in even the faintest light assume various colors. The presence of oxygen is necessary, according to Wiesner, in order that the rays of light may effect the decomposition of chlorophyll, and this author has made an interesting investigation into the action of different portions of the spectrum. He concludes that all the chemical changes caused in chlorophyll cells by the rays of light (namely, their development, decomposition, and assimilation of other substances) take place most rapidly in the brightest portion of the spectrum; and that, while all portions of the visible spectrum have the power of inducing these changes, the mechanical effects of light upon plants are to be especially ascribed to the rays of high refrangibility.—*Poggendorff Annalen*, CLII., 503.

EXPERIMENTS ON THE VELOCITY OF LIGHT.

While astronomy has been busy with the problem of the sun's distance, physics has contributed an independent solution to this question. M. Cornu, of the French Academy of Sciences, has repeated the celebrated experiments on the velocity of light which were proposed by Foucault and Fizeau some twenty-five years ago. He has himself improved the method of Fizeau, and his experiments were exhaustively conducted and have been perfectly successful.

M. Cornu chose for his two stations the Observatory of Paris and the tower of Montlhéry, whose distance apart (about fifteen miles) is very precisely known. The beam of light passing from the observatory fell upon a toothed wheel revolving no less than 1600 times per second; a portion of the beam, escaping through the interval between two teeth, passed on to a reflector at Montlhéry, and returned thence to the revolving wheel. If the rotation of the wheel during the time required for the light to travel to and fro over twice the distance between the two stations interposes a tooth in the path of the returning ray, an extinction of the luminous impression occurs, and from the known velocity of rotation of the wheel, and from the known distance of the stations, the velocity of light can be had. By revolving the wheel at different rates this extinction can be made to occur at the fourth, fifth, sixth, etc., tooth. A great accordance characterizes Cornu's results, and high importance attaches to this delicate research. All the observations were made at night by the aid of a Drummond light, except one which was made by sunlight. Exceptionally still weather was chosen for each experiment. From these observations there results a velocity for light *in vacuo* of 300,400 kilometers per second (186,700 English miles), with a probable error of less than $\frac{1}{1000}$ of the whole amount. The solar parallax is directly deducible from Cornu's velocity of light in two ways. Thus, combining it with Delambre's value for the *equation of light*, we find a solar parallax of 8.88″, while Bradley's value of the *aberration of light* gives a parallax of 8.88″, and Struve's value of the *aberration* constant gives 8.80″. M. Cornu in his elegant memoir gives a summary of the values of the sun's parallax as deduced by various methods. The harmony of the results is marvelous when we consider with how minute a quantity we are dealing. The eight values that may be thus deduced range between 8.80″ and 8.88″; and it is possible that the transit of Venus may not give a much better determination.

AUTOMATIC REGISTRATION OF THE CHEMICAL ACTION OF LIGHT.

The measurement of the chemical intensity of the solar light has not yet become a subject of regular meteorological observation, because of the want of a proper instrument. This want is now partly supplied by a method proposed by Roscoe, who proposes to effect the measurement by the blackening of a paper saturated with chloride of silver; or, rather, by means of the time required in order that the exposure to the light may bring about a given intensity of shade. A uniformly prepared paper is placed in the apparatus during the previous night, and is, by a mechanical arrangement, hourly exposed during a given interval to the sunlight. In order to estimate correctly the intensity of the solar action, Roscoe arranges the apparatus so that the paper shall, each hour, many times in quick succession, be exposed to the light for from two to thirty seconds. We thus have, at each hour of the day, a complete series of small spots of various tints, and have only to seek that tint which corresponds to the normal to know at once the number of seconds of exposure corresponding to the strength of the sunlight at that time. A series of observations made during the months of May, June, and July have given very accordant results in the hands of Roscoe.—19 *C*, VII., 202.

NEW METHOD OF MEASURING THE VELOCITY OF LIGHT.

A simple and possibly accurate method of measuring the velocity of light is suggested by Mr. Burgue. A disk, turning very rapidly about its axis, is at each turn to be illuminated by an intermittent and instantaneous light. A single dark radial line on the disk will seem at rest, like the disk itself. Now withdraw the source of light to a distance, and the time the light takes to reach and illuminate the disk will become greater, and the position of the radial line will appear displaced to a new position, forming with its previous position a certain small angle, which will measure the time of the light's passage over a given distance.—1 *A*, II., 262.

GREAT FRENCH LIGHT-HOUSE AT LA HAVE.

The great French light-house at La Have, near Havre, is said to be the most magnificent establishment of its kind in the world. The electric light was first used at this place in 1863. The electricity is furnished by magneto-electric machines, and the simple uncondensed beam of light is equal to 4000 candles, and it seems to be the testimony of navigators that this electric light is always seen, even in clear weather, before the oil lamps nearer them. Its range of visibility is also correspondingly greater, the radius of the circle lighted up being from five to ten miles greater than that of first-class oil lamps. The difference between the two is, in fact, similar to the comparison of a candle and a gas-light. At some distance there is also a notable difference in their aspects, the electric light appearing white and brilliant, the other red and smoky. The superiority of the former is still more manifest during foggy weather, since at such times, even before perceiving the electric light, its presence is marked by the illumination of the thick atmosphere surrounding it, and its range thus increased. This is an important advantage of the electric light, and may be of great practical utility, as has, in reality, frequently been the case. While its brilliancy gives it this superiority, its inferior power of penetration diminishes the range of the electric light in foggy weather, and more notably as the fog thickens. In general, it is found that if the electric light has an intensity two and a half times greater than the oil-light, it will penetrate fog as well as the latter. The expense of the powerful electric light at La Have is about one seventh greater than that of the decidedly inferior oil-lights. General testimony seems to be in favor of the introduction of the magneto-electric light at all important stations, and both the English and French are extending its application.—*Elliot's European Light-house System*, p. 248.

THE ROMAN PHAROS IN DOVER CASTLE.

There is still standing within the walls of the castle at Dover, England, an old Roman pharos. The antiquity of this light-house, which has probably not been used as such since the Norman conquest, no doubt exceeds that of any light-house in Great Britain, it having been built, as is supposed, about A.D. 44. Upon it burned for many centuries great fires of wood or coal, the modern system of lamps and reflectors having superseded coal fires during the last century. This pharos, like the one at Boulogne, is built of bricks in color and shape like those found elsewhere in the Roman structures of Great Britain. They are of a light red color, about fourteen inches long, and not more than an inch and a half thick. The mortar joints are of nearly the same thickness. The preservation of this famous relic is doubtless due to the fact that some centuries ago the tower was turned into a belfry, and was surrounded by walls of stone. The latter are now nearly destroyed by time, and the old remaining work is again exposed.—*Elliot's European Light-house System*, p. 73.

THE POWER OF THE ELECTRIC LIGHT.

The most powerful artificial light at present in existence is that employed for the great light-house at Souter Point, on the coast of England, near the mouth of the Tyne.

On both banks of this river there is an immense number of manufactories of all kinds, the smoke from which, under the influence of the west wind, seriously obstructs the approaches from the sea. Fogs at this part of the coast are also frequent; and the problem of light-house illumination required that such light should be secured as would penetrate through any slight fog or haze, it having been generally acknowledged that not even the sunlight itself can penetrate an ordinary dense fog. The electric light established at Souter Point after condensation is equal in power to 800,000 standard candles, being eight times as powerful as the best American fixed lights. The electric spark passes between slender pencils of carbon, which are themselves consumed at the rate of about one inch per hour. The electric current is generated by two of Professor Holmes's patent rotary magneto-electric machines, driven by steam-engines of six horsepower. The number of revolutions made by each machine is 400 per minute, and 12,800 sparks pass per minute when both machines are at work. These sparks are, of course, formed so rapidly that the eye does not separate them, and the result is an intense beam of light, so dazzling that the eye of a person within the lantern can not rest upon them for an instant without intense pain. As observed from a distance of several miles, this light is so bright as to cast a well-defined shadow upon the deck of a vessel.—*Elliot's European Light-house System*, p. 120.

ELECTRIC LIGHT FOR LOCOMOTIVES.

A series of satisfactory experiments has lately been made in Russia in regard to lighting railway tracks from the locomotives by means of the electric light. The track on one occasion, with a battery of forty-eight cells, was brilliantly illuminated 492 yards ahead.—23 *A*, *April* 9, 1875, 467.

THE BLACK-BULB-IN-VACUUM THERMOMETER.

As is well known, the black-bulb-vacuum thermometers employed for observing the solar radiation give very discordant results, even in the hands of the best observers, and the origin of this has recently been studied by Mr. Hicks, of London, who states that in his opinion the discordances are in a great measure due to the imperfect vacuum that exists within the inclosing bulb. Having made a large number of thermometers with special care, in which the vacuum has been reduced to the lowest attainable limit, Mr. Hicks finds that it is possible with proper care to always construct instruments that shall be perfectly comparable with each other. In order that the meteorologist may at any time test the perfection of the vacuum within his tube, Mr. Hicks has very ingeniously inserted two wires into the sides of the bulb in such a way that a galvanic current applied to the wires will, by the nature of the light that is spread through the vacuum bulb, show with considerable accuracy what proportion of gas, and especially of watery vapor, is there present. A pressure within the vacuum bulb exceeding one tenth of an inch of mercury is not admissible if an accurate instrument is desired, and the vacuum can be easily brought to within one fiftieth of an inch, in which condition the radiation solar thermometers will prove strictly comparable. Especially is it important that the bulb should be filled with dry gas, and that not the slightest trace of moisture should exist. Mr. Hicks said that, although he had made hundreds of tubes with Torricellian vacua, he never knew one to fail showing stratification and white light when the tube was thoroughly clean and free from moisture.—*Quar. Jour. Meteor. Soc.*, II., *April*, 1874.

THE THERMAL CONDUCTIVITY OF MERCURY.

Herwig has been continuing the inquiry previously instituted as to whether the thermal conductivity of mercury varies with the temperature—a question of much moment in connection with the reliability of the indications of the mercurial thermometer at different temperatures. He finds that between 40° and 160° Centigrade the heat-conducting power of pure mercury is perfectly constant. He is now occupied in a series of experiments to show how far solid metals differ in their behavior from mercury.—13 *A*, *Feb.* 27, 1875, 222.

A NEW SOURCE OF ERROR WITH THE MERCURIAL THERMOMETER.

Mr. J. M. Morgan, in employing a mercurial thermometer in the operation of distillation, the instrument being inserted into the apparatus to such a depth that the whole of the quicksilver thread was surrounded by heated vapors, observed after the operation had continued for several days that the temperature registered was too low by 3°. An examination showed that this error was due to the fact that a portion of the mercury had vaporized and condensed in the upper part of the tube which was not exposed to the heat of the operation. When the portion condensed in the upper end of the tube was united, by cautious tapping, with the main column, the instrument again registered correctly. The observer of this phenomenon determined thereupon by experiment that a quantity of mercury corresponding to from 1° to 15° will be volatilized in the manner described if the mercury column of a thermometer is exposed for several days to a temperature of from 60° to 100° Centigrade. This observation is worthy of the special attention of experimenters, since the small quantity of mercury thus condensed in the upper end of the thermometer tube may be readily overlooked, and thus give rise to serious errors of observation.—*Fresenius's Zeitsch. für Analyt. Chem.*, XIV., 81.

RELIABILITY OF SIEMENS'S PYROMETER.

The Siemens pyrometer has been subject to a careful investigation by a committee of the British Association, in order to decide whether or not the resistance is altered after exposure to high temperatures. Four instruments were examined, three of which were found to be considerably altered after having been exposed to a high temperature; the fourth gave results showing it to be sufficient for industrial application, if not for strictly scientific observations.—12 *A*, X., 373.

A NEW MERCURIAL MINIMUM AND MAXIMUM THERMOMETER.

Mr. Denton describes a maximum and minimum thermometer combined in one, by which both registrations of temperature are obtained from one mercurial bulb, both indices are moved by the mercury pressing on their ends, and, independent of the self-registering feature, the actual temperature is shown, at any moment, by two separate columns of mercury. In the construction of the instrument the tube of the maximum thermometer is bent at the top and turned downward, and dips into an hermetically sealed chamber, which is itself more than half filled with mercury. An increase of temperature raises the index of the maximum thermometer and pushes down the mercury in the other leg of the tube. A diminution of temperature leaves the maximum index in its place, and allows the mercury in the other leg of the tube to rise, pushing up with it its index, which is, in its turn, left in its place where the maximum thermometer has passed. The graduations of the second or minimum stem of the thermometer are counted downward, and those of the maximum stem are counted upward. As constructed by Casella, it is said this instrument is extremely sensitive, convenient, and reliable.—*Quar. Jour. Meteor. Soc. of London*, 1875, II., 193.

NEW SELF-RECORDING THERMOMETER.

In constructing a thermometer in which the dilatation of the metal shall give the measure of the temperature of the air, Tremeschini states that he has endeavored to eliminate the inconvenience peculiar to the nature of glass by making use of a metallic band as an indicator of the temperature. In his thermometer, which he exhibited lately to the French Meteorological Society, he employs a band of copper slightly platinized in order to preserve it from oxidation. This band is nine centimeters long and seven millimeters broad, and has a thickness of one twentieth of a millimeter, and is therefore extremely sensitive to atmospheric temperature changes: it is coiled about a central axis, very much like the hair-spring of a watch, and is contained within a case similar to that of an ordinary aneroïd barometer. The temperature is read on the face of the thermometer by an index, which may even describe an entire circle in passing from —40° to +100° Fahrenheit.—*Nouv. Meteor.*, 1875, 14.

ON THE EXPANSION OF INDIA RUBBER BY HEAT.

According to the studies of Schmulewitsch, based in part on the studies of Puschl and Exner, as well as his own experiments, the somewhat anomalous behavior of caoutchouc under the influence of heat may be expressed by the following four propositions: First, caoutchouc is a body whose density is a minimum at a certain temperature. Second, this minimum temperature changes with the mechanical extension, being lower the more the body is extended by the application of some external force. Third, in the case of caoutchouc unexposed to any strain, the temperature of the minimum density is higher than ordinary temperatures, but approaches the latter by heating; its co-efficient of expansion is positive, but diminishes with increasing temperature. Fourth, in the case of strongly extended caoutchouc, the temperature at which its density is a minimum is lower than ordinary temperatures; its co-efficient of expansion is therefore negative at the latter temperature, and increases numerically with the temperature.—19 *C*, VIII., 146.

ON THE MOLECULAR HEATS OF SIMILAR COMPOUNDS.

Professor F. W. Clarke states that as the result of an extensive comparison between the molecular heats of similar compounds, he finds that these have equal values, not at the same temperature, but at what are called corresponding temperatures, which are at equal or nearly equal distances from the respective melting points.—*Bull. Phil. Soc. Washington, June*, 1874.

ON THE REPULSION DUE TO HEAT.

In his reply to the criticism of Professor Reynolds, Professor Crookes states that abundant observations which have been accumulated by him during some years appear in every way to contradict the theory that the phenomena observed by him are due either to air-currents existing within vacuum tubes or to electrical phenomena. As to the theory of Professor Reynolds, that the effects are the results of evaporation and condensation, he satisfactorily shows that while this explanation might sometimes be admissible, yet in general it requires the adoption of assumptions that seem to be wholly at variance with the facts. He concludes by stating his belief that the repulsion observed by him as accompanying the radiation of heat and light is directly due to the impact of the waves upon the surface of the moving mass, and is not a secondary effect through the intervention of air-currents, or electricity, condensation, etc. Whether the æthereal waves actually strike the object moved, or whether at the boundary of the surface, solid or gaseous, there are intermediate layers of condensed gas which, taking up the blow, pass it on to the layer beneath, are problems the solution of which must be left to further research; and, without insisting upon any theory of his own, he proposes it merely as a useful working hypothesis. Any theory will account for some facts, but only the true explanation will satisfy all the conditions of the problem, and this can not be said of either of the theories which have thus far been discussed. To quote the eloquent language of Sir Humphrey Davy, "When I consider the variety of theories which may be formed on the basis of one or two facts, I am convinced it is the business of the true philosopher to avoid them altogether. It is more laborious to accumulate facts than to reason concerning them; but one good experiment is of more value than the ingenuity of a brain like Newton's."—7 *A*, XLVIII., 94.

THE SPECIFIC HEAT AND CUBIC EXPANSION OF BODIES.

Mr. Walter Spring communicates to the Royal Academy of Belgium the following note with reference to the specific heat of bodies. He states that he sought to determine whether there were any relation between the specific heats and the co-efficients of cubic expansion by heat. He arrives at very beautiful results, both practically and theoretically. For instance, the computations which he makes of the specific heats of mercury and of graphite agree to the fourth decimal place with the observations of Regnault, Dulong, and Petit. He concludes that the product obtained by multiplying the specific heat of any body by its atomic weight can not be constant, since the specific heat is itself a function of a variable factor.—*Bulletin of the Royal Academy of Belgium*, 1874, 294.

LIGHTNING-CONDUCTORS.

In a few remarks upon the action of lightning-conductors, Secchi, the well-known astronomer, describes the storm of November, 1872, in which the cathedral and palace of Alatri were struck by lightning, these structures having been free from such visitations for many years. The damage done on this occasion was, as he shows, due in great measure to the fact that the lightning-rods, instead of being directly connected with the metallic gutters and other portions of the roof, were isolated from them. The fluid, therefore, sought to make its own way to such other good conductors as were near. After quoting other instances, he expressed the opinion that the conditions most favorable to safety consist in joining the lightning-rod directly to all the metallic portions of the roof, and especially to the rain-water pipes, in order that greater facility may be offered to the electric fluid in its passage to the earth.—*American Engineer*, I., 122.

ATMOSPHERIC ELECTRICITY IN SPITZBERGEN.

In reference to the observations of atmospheric electricity in high northern latitudes, in which, as yet, our instruments have generally given negative results, Wijkander states that the late Swedish polar expedition gave special attention to this subject, and that all their observations show that at relatively high temperatures the air conducts electricity very well, to which fact is ascribed the absence of lightning and the presence of the Northern Lights. It has been said that these latter phenomena depend upon the great moisture of the air in these regions; but it seems clear that the polar light is conditioned by other circumstances, since the same temperature and the same degree of humidity do not bring forth these results in other latitudes.—19 *C*, VII., 422.

VELOCITY OF THE TRANSMISSION OF ELECTRIC FORCE.

The question as to whether electric and magnetic forces require sensible time to exert their influence, at a distance, has been made the subject of numerous investigations, one of the most interesting of which is that of Herwig, who has endeavored to conduct experiments upon as large a scale as possible. The preliminary results to which he was led have, he thinks, justified him in formulating the conclusion that if the terrestrial magnetic influence has any definite velocity of transmission whatever, it must be at least at the rate of half a million of miles per second; and that the influence of the earth's magnetism at any point of the earth's surface attains its full degree within $\frac{1}{300}$ of a second.—19 *C*, VIII., 30.

EDLUND'S THEORY OF THE NATURE OF ELECTRICITY.

In a report on the theory lately advanced by Professor Edlund as to the nature of electricity, Dr. Emsmann states that apparently Edlund has, in this matter, taken such a step forward as was made when previous investigators were able, by means of one æther, to explain both optical and thermal phenomena. Edlund's theory consists essentially in ascribing to the æther itself an inertia which necessitates a slight interval of time in order to affect its movement. The flow of æther from one body to another explains the electro-dynamic phenomena, while its abundance or deficiency in any body serves to explain the electro-static phenomena. As regards the chemical influence of the galvanic current, it is assumed that the electricity has an equal influence upon the bodies that are to be separated or combined by it. The rotation of the plane of polarization of light is elucidated by the simple assumption that the electric æther is not different from the optical æther, and it must be acknowledged that Edlund's theory is based upon well-known facts, and is distinguished by its simplicity and sufficiency.—7 *C*, X., 402.

ON THE ELECTRICITY OF MINERAL WATERS.

Professor Theury, of Geneva, and Dr. Minnich have conducted some remarkable experiments in reference to the electrified condition of the mineral waters of certain springs, respecting one of which, the Stadthof, near Baden, in Switzerland, they state that their experiments show that the warm water at its escape from the soil is quite strongly electrified, it being negatively electrified with reference to the electric current at the thermal spring at Limmat. The currents observed by them are not the result of any thermo-electric action, nor are they the result of any special electric chemical action between the carbonic acid gas and the platinum electrode, but appear to them to be peculiar to the spring-water itself.—13 *B*, III., 186.

THE STRATIFICATION OF ELECTRIC DISCHARGES IN VACUO.

Messrs. De la Rue, Miller, and Spottiswoode have conducted a long series of investigations looking to the ascertainment of the cause of the stratification of electrical discharges in vacuo. Without bringing their investigations to a close, or pointing out any conclusions as distinctly reached, it is evident from their experiments that the stratification is due to a peculiarity in the flow of the electricity, which flow is apparently of the nature of an intermittent discharge, whose periodical overflows, so to speak, take place at very short intervals, and whenever the current acquires strength enough to overcome the resistance offered by the rarefied medium through which it must flow.

EARTH-CURRENTS ON TELEGRAPHIC LINES.

The Asiatic Society of Bengal, in consideration of the important labors of Mr. Schwendler, has taken steps to influence the government of India to especially investigate the subject of earth-currents on telegraph lines—a work which ought, in the interest both of science and art, to be taken up not only by the European governmental, but by American private telegraph companies.

ON UNILATERAL CONDUCTIVITY OF ELECTRICITY.

While engaged in other work, Dr. Schuster states that he met with an irregularity which seemed to be of such a peculiar nature that he subjected it to a separate investigation; although he is not yet able to raise this phenomenon above the rank of an irregularity, yet his experiments leave no doubt as to the fact. It seems to him clear that the current produced by an electro-motive force in a circuit composed entirely of copper wires, joined together by means of binding screens, may under certain circumstances be different from the current produced by the same electro-motive force acting in an opposite direction. He calls this phenomenon "Unilateral Conductivity." The most plausible explanation seems to him to be that a thin layer of air may sometimes intervene between the two wires that are screwed together, an explanation that has been confirmed by some experiments, while others show that it is insufficient.—7 *A*, XLVIII., 246.

THE ELECTRIC CHARGE OF A CONDUCTING WIRE.

The researches of various physicists have proved that an electric current, before it can circulate in any conductor, must charge it electrically, and consequently in the entrance of a current into the circuit two periods are distinguished. In the first the wire is charged, the current passing through a variable state until it gradually acquires its normal value. In the second period the current has become constant, and its value depends on the conditions determined by Ohm's law. According to Villari, the first or variable state has no constant duration; it increases with the length and condition of the circuit, and also with the so-called co-efficient of charge of the wire, which co-efficient is measured by the quantity of electricity necessary to give a unit's charge to a unit's length of wire. This co-efficient of charge varies with every metal, and with it varies the duration of the current's variable state; the quantity of electricity which the current consumes to establish itself is with the different metals also variable.—18 *A*, XX., 4.

THE ACTION OF ELECTRICITY ON PHOSPHORUS.

In 1860 Dr. Giessler endeavored to show that electricity of itself can effect the conversion of ordinary phosphorus into amorphous phosphorus. An apparatus recently devised by Schwendler shows that the conversion of the phosphorus is effected even by the inducing action of the current of electricity. For this purpose the ends of two conducting wires are inserted into exhausted spheres in which there is no phosphorus. These spheres are inclosed in others, and the space between (likewise exhausted of air) contains the phosphorus, which is therefore completely shut off from the conducting wires by a screen of glass. On the passage of a current the sides of the spheres become coated with amorphous phosphorus. It may be considered demonstrated that this conversion is effected neither by the light nor by the heat that accompany the current, but exclusively by the electricity itself.

THE DIFFERENCES BETWEEN VOLTAIC AND FRICTIONAL ELECTRICITIES.

In reference to the difference between electricity developed by friction and that developed in the galvanic battery, it has long been remarked that the former, or electricity of high tension, as it is called, excels the other in the development of light by the electric spark, and has a stronger physiological effect upon the nerves and muscles, while its chemical, thermic, and electro-magnetic effects are much weaker. A further difference between these two sources of electricity consists in this, that the galvanic current follows the law of Ohm, varying its intensity with the resistance between its poles, while the current from the electric machine, as was shown by Gauss, remains constant, no matter how great the resistance of the bodies penetrated by it. The study of the failure of Ohm's formula in this case has been the subject of an investigation by Rossetti, who, among many other conclusions, establishes the following principles: In one and the same series of experiments, conducted under identical circumstances with reference to atmospheric humidity, the intensity of the current excited by the electric machine is nearly, but not exactly, proportional to the velocity of the revolving disk. The relation between the velocity of the disk and the intensity of the current is not independent of the moisture in the air, but varies sensibly therewith, the number of turns the disk must make in a second, in order that a current of constant intensity may be developed, is greater on moist than on dry days. The work required to make the electric machine active is exactly proportional to the intensity of the current, assuming that the humidity remains the same. The ratio between the work and the intensity of the current diminishes with increasing moisture, so that in order, on a moist day, to obtain a current of given intensity, there may indeed be required a greater velocity of rotation; but equally is it true that a less amount of work would be expended, so that the electric machine is more economical on moist days than on dry.—19 *C*, VIII., 140.

NEW MODIFICATION OF THE LECLANCHÉ BATTERY.

M. Kern, of St. Petersburg, after detailing several grave objectionable qualities of the Leclanché cell, at present very popular for telegraphic and other uses, recommends the following modification, which he claims will act very constantly. Two parts of well-washed coke and one of manganese dioxide, in the state of powder, are well mixed together with a small quantity of water acidulated with some drops of nitric acid, and the mixture is then pressed into a cylindrical mould of suitable size. The resulting coke-manganese cylinders are dried in a warm place, but not over a fire, as a strong heat will decompose the peroxide. The dried cylinders are placed in glass jars containing concentrated solution of ammonium chloride, and surrounded with zinc plates curved in the usual manner. By this arrangement the use of porous cells is avoided, and a battery of such elements acts more constantly, besides which the construction is materially cheapened. For the glass jar, the author furthermore substitutes a wooden box of the same size, coated with a mixture of wax, two parts; resin, ten parts; red-lead, two parts; and gypsum, one-sixth part.—1 *A*, XXXI., 203.

SIMPLE METHOD OF MAKING CARBON CELLS.

Mr. Symons gives the following method, as practiced by himself, for constructing plates or cells of carbon of any required shape and size, such as are used in galvanic batteries. With a sirup of equal quantities of lump sugar and water, mix wood charcoal, in powder, with about equal parts of the light powder called vegetable black. The mixture should hang well to the moulds dipped into it, and yet be sufficiently free to form itself into a smooth surface. Moulds of the cells required are made of stiff paper, and secured by wax or shellac. These moulds are dipped into the carbon sirup, so as to cover the outside only, and then allowed to dry. This dipping and drying ought to be repeated until the cells are sufficiently thick; when well dried they are buried in sand, and baked in an oven hot enough to destroy the paper mould. After being cleared from the sand and burned paper, the cells are soaked for some hours in diluted hydrochloric acid, and again well dried, then soaked in sugar sirup. When dried, they are packed with sand in an iron box, gradually raised to a white heat, and left to cool. If some of the cells be cracked, they need not be rejected, but covered with paper or plaster and dipped into melted paraffin. Rods or plates of carbon can be made by a similar process. The carbon thus made will be found to have a good metallic ring, and a brilliant fracture.—12 *A*, XI., 8.

NEW ABSOLUTE GALVANOMETER.

An absolute galvanometer is described by Professor Guthrie, as constructed for him by the Messrs. Elliott. Its principle consists in the determination of the strength of the current, by the measurement of the mechanical force necessary to bring to within a given distance of one another two electro-magnets which are affected by the current in such a manner that they repel one another. The galvanic current whose force is to be measured coils around two fixed soft iron masses, rendering them magnetic, and then around two movable soft iron masses suspended by a vertical thread. Many of the laws of electro-dynamics may be readily illustrated by this instrument, and not only may different currents be compared with the greatest accuracy, but the absolute mechanical value of the current may be at once arrived at.—7 *A*, XLVIII., 297.

EARTH CURRENTS IN TELEGRAPH LINES.

Mr. Schwendler, who in 1868 was intrusted with the introduction of a system of testing telegraph lines in India, took that opportunity to do his work so thoroughly as to secure all the data necessary for the quantitative determination of the electro-motive force on the line. Over 10,000 determinations have been made during the past six years, and he deduces from these the conclusion that all the lines in India are affected by natural currents of electricity. These currents are, as it were, a negative or copper current, flowing from the east to the west. The strength of the natural current is very variable, even on the same line. The direction is also variable, but far more constant than the strength. The variations in strength and direction, on parallel lines of telegraph, are very uniform. The prevailing direction of the current is generally also the direction of the maximum current. He considers himself now fully justified in establishing further improvements for the purpose of minutely investigating these currents, and his propositions having been strongly urged upon the attention of the Indian government, have been favorably received by it.—*Proc. Asiatic Soc. Bengal, June*, 1874, 145.

VARIATIONS OF SHIPS' COMPASSES.

Sir William Thomson communicates to the British Association for the Advancement of Science an investigation of the perturbations of the compass produced by the rolling of the ship—the so-called "heeling error" which has been studied by Airy and Smith. This heeling error may be defined as the angle between the directions for the ship upright and the ship inclined, the resultant of the horizontal magnetic forces of the earth and the ship at the position of the compass—a definition that would be rigorous for a compass supported on a point in the ordinary manner, if this bearing-point were carried by the ship uniformly in a straight line, and is sufficiently approximate when the compass is placed in the ship's axis of rolling. The perturbation produced in the compass by this rolling will be solely that due to the variation of the horizontal component of the ship's magnetic force. Such a position of the compass would have one great advantage, viz., that the application of proper magnetic correctors adjusted by trial, to do away with the rolling error, would also perfectly correct the heeling error.—7 *A*, XLVIII., 364.

THE FORMATION OF MAGNETS BY ELECTROLYSIS.

In a recent notice of the labors of Jacobi, Beetz considers the question of the formation of magnets by electrolysis. The latter states that on causing iron to be deposited by galvanic action in the interior of a coil, he subsequently found the iron to be magnetic. To secure this result his cathode was a plain metallic plate, opposed to a similar iron plate which acted as a node. An attempt by Jacobi to produce similar action seems to have failed, and the reason for its failure is explained by Beetz as resulting principally from the fact that the electrodes employed by Jacobi were of such a nature, and so arranged, that it was impossible to induce any magnetism in the iron deposited between them; in fact, the molecules of the latter were deposited in a magnetic shade so intense that less than 0.01 of the electro-motive force affected it.—*Poggendorff Annalen*, CLII., 486.

MEASUREMENTS OF TERRESTRIAL MAGNETISM.

Attention is called by Braun to the practicability of applying the inclinatorium to the determination of the intensity of terrestrial magnetism. This was first suggested and applied by Lamont and Lloyd, but seems to have been generally neglected. Braun, however, shows that both theory and practice agree in proving that this method allows of the same degree of accuracy as that attainable by the best magnetometers. In detail he finds that Lloyd's method gives the total intensity more accurately than the horizontal intensity, but by the magnetometer method the reverse is the case. The accuracy of the results obtained by Braun is attributed, in part, to the great perfection of the inclination needles that are now made in England, and he recommends earnestly the inclinatorium as a portable magnetic instrument, upon the score of accuracy, convenience, and cheapness; since with it one may make a complete series of magnetic observations, without also carrying declinometer, magnetometer, reflecting circle, theodolite, or clock. A simple addition to the instrument even allows him to make absolute as well as relative determinations.—*Poggendorff Annalen*, CLII., 619.

NEW METHOD OF INVESTIGATING TERRESTRIAL MAGNETISM.

In an inaugural dissertation of Dr. Haanel, of Albion, Michigan, recently printed at Breslau, Germany, the advantages of the galvano-metric method for the determination of the earth's magnetism and its oscillations are elucidated; he concludes that the method is well adapted to such determinations, and that it will recommend itself by the following advantages: The instrumental constants need be determined only once for all subsequent observations; the oscillations of the declination may be eliminated by properly arranging the observations; Gauss's method of counting the vibrations is dispensed with; the magnetic power of the coil can be increased or diminished at pleasure; and the oscillations of the coil are under perfect control of the observer.—*Haanel's Inaugural Dissertation*, *Breslau*, 1873, 128.

THE EFFECT OF MAGNETISM ON THE ELECTRIC DISCHARGE.

The last work published by A. De la Rive relates to this subject, in the early development of which he took so active a part, namely, the effect of magnetism on the electric discharge when the latter takes place through a rarefied gas. In an earlier memoir on this subject he studied the case of the magnet acting upon a discharge, the latter being perpendicular to the magnet. He showed that in this case the magnetism produced not only a deviation of the luminous jet, but its condensation, its more intense brilliancy, and a notable diminution of the elastic force of the gas in the portion of the discharge which is more directly submitted to the magnetic action. This augmentation of intensity varies with the nature of the gas. It is least with hydrogen and greatest with air; that is to say, the effect is more marked in proportion as the gas is a less good conductor of electricity, and the effect is more considerable on that portion of the discharge near the electrode than upon the rest of the column. The electric conductivity of the gas also diminishes, owing to the action of the magnet, and by a quantity that varies very notably with the nature of the gas, being so much more considerable as the gas is a better conductor of electricity. As the result of his later investigations, De la Rive finds that when the magnet is presented to the gas influenced by the electric discharge in such a way that the axis of the magnet is not perpendicular, but parallel to the axis of the discharge, and is, in fact, a continuation of the latter, then all the preceding phenomena are reversed. Further experiments showed that a special and peculiarly intense resistance, having its seat at the issue from the negative electrode, is that which is overcome by the intervention of the magnet. The dimensions of the negative electrode notably influence the dimensions of the aureola.—7 *A*, XLVII., 464.

FORMATION OF MAGNETISM BY ELECTRIC CURRENTS.

Some researches made by Beetz into the possibility of communicating permanent magnetism to the iron deposited by galvanic currents have an interesting bearing, not only upon chemical, but also upon geological theories; he states as the result of investigations into the influence of the chemical nature of the solution employed as an electrolyte, that the iron deposited from solutions containing sal ammoniac is in a peculiar manner susceptible to the reception of permanent magnetism. If the deposition takes place under the influence of a strong magnetism, avoiding injurious circumstances, there are formed from the sal-ammoniac solution strong magnets of uniform structure, while from solutions having no sal ammoniac magnets are formed whose structure is irregular, and whose magnetic power is quite feeble.—*Poggendorff Annalen*, CLII., 494.

THE INFLUENCE OF A MAGNET UPON THE GALVANIC ARCH.

Messrs. Delarie and Sarasin have published the result of some experiments concerning the effects of magnetism on the electric discharge through rarefied gas when the discharge occurs in the prolongation of the axis of the magnet; various gases, sealed up in Geissler tubes, have been experimented upon, the discharge from a Ruhmkorff coil being allowed to traverse the gas. Changes occur in the appearance of the luminous discharge where the magnet is excited; these changes are accompanied by a change in the resistance offered to the current by the gas. Thus a tube containing hydrogen permitted the passage of a current marking twenty-five degrees on the galvanometer when the magnet was not excited, but when excited the galvanometer reading was forty degrees. It seems to be a law that the augmentation in the intensity of the current is greater with a gas which is a good conductor than with one which is a bad conductor.—12 *A*, XI., 19.

NEW SOURCE OF MAGNETISM.

M. Donati Tommasi is authority for the statement that if a current of steam at a pressure of from five to six atmospheres is passed through a copper tube of two to three millimeters in diameter, which is spirally coiled about an iron cylinder, the latter is magnetized so effectually that an iron needle, placed at the distance of some centimeters from the steam magnet, is strongly attracted, and remains magnetic so long as the steam is allowed to pass through the copper spiral.—6 *B*, XV., 1875.

MAGNETIC PERMEABILITY OF IRON, NICKEL, ETC.

Mr. Rowland, of Troy, New York, in a paper on the magnetic permeability of nickel and cobalt, states that the views of the English and German philosophers as to the nature of force have given rise to different ways of looking upon magnetic induction. Thus, the Germans would say that this action was due in part to two causes—the attraction of the coil and the magnetism induced in the iron by the coil; the English, following Faraday, on the other hand, would consider the substance in the helix as merely conducting the lines of force, so that no action would be exerted directly on the compass needle by the coil; but the latter would only affect it in virtue of the lines of force passing along its interior, and so there could be no attraction in a perfectly vacant space. According to the first theory, the magnetization of the iron is represented by the excess of the action of the electric magnet over that of the coil; while by the second theory, when the coil is very close around the iron, the whole action is due to the magnetism of the iron. The natural unit of magnetism to be used in the first theory is that quantity which will repel an equal quantity at a unit's distance with a unit of force. On the second theory, it is the number of lines of force which pass through a unit of surface when that surface is placed in a unit field perpendicular to the lines of force. As the result of his novel and very important researches on the effect of heat on magnetism, Rowland states that if it were possible for the magnetism of substance to attain a maximum value, the co-efficient of magnetism by induction would become, first, zero, and then negative, and the substance would then become diamagnetic for very high magnetizing forces. This principle, announced independently by Maxwell and Rowland, lacks as yet the confirmation of observation, although not contrary to our experience. Our principal hope of confirming it by observation consists in heating some body, and then subjecting it to a very high magnetizing force, for Rowland has shown in the case of iron and nickel the maximum of magnetization of nickel and of iron decreases as the temperature rises, at least between the limits of zero and 220° Centigrade. He finds from observation that if nickel is heated from 15° to 220° Centigrade, the magnetization will increase if the magnetizing force is small, but will decrease if it is large. In general, as the magnetizing force is increased, the resistance of iron, nickel, and cobalt to magnetization decreases, until a minimum is reached when the metals have attained a magnetization equal to from 24 to 30 per cent. of their maximum of magnetization, and after that resistance increased indefinitely.—7 *A*, XLVIII., 32.

IMPROVEMENTS IN THE GRAMME MAGNETO-ELECTRIC MACHINE.

The magneto-electric machine invented by Gramme, which has within the past two years become quite famous, has received an important improvement in that ordinary magnets have been replaced by the plate magnets invented by Jamin, which give it a great advantage, not only because of the greater force for the same weight, but because of the extreme facility of their construction. These plate magnets can be built up and taken apart in a few minutes, an extremely valuable feature when one is obliged to experiment in order to determine the strength of the current necessary for accomplishing a certain work, and one equally valuable to the physicist who may desire to elucidate obscure points in the theory of the machine. The Gramme machine has been still further improved by combining with its peculiar features the construction due to Wild and Ladd, by which an immense magnetic power is developed from a very slight initial movement of magnetism; by this means an instrument has been produced by which the same electric tension is attained with a velocity one half as great as that originally necessary. In the course of the numerous improvements that Mr. Gramme has made in his original machine, his latest construction seems to leave nothing to be desired. The number of electro-magnets and of coils is now reduced, from six and twelve respectively, to two and four. The ring is virtually doubled, giving far more facility in the application of the same machine to very different objects, such as galvanoplasty, lighting, heating, etc.; in the machines, as originally constructed with a simple ring, each one was only convenient for use for the immediate purpose for which it was designed and proportioned.—13 *B*, III., 139.

THE FRICTION AND THERMAL CONDUCTIVITY OF GASES.

In a memoir by Messrs. Kundt & Warburg on the friction and thermal conductivity of gases for heat, the authors endeavor to investigate the accuracy, at high temperatures and low densities, of the laws deduced by Maxwell, Meyer, Loschmidt, Stefan, and Boltzmann, which for ordinary temperatures and densities hold good in gases; they find, first, that the co-efficient of sliding friction between moving gas and a fixed plane has a determinate value dependent on the nature of the gas, so long as this is present in layers thicker than fourteen times "the mean length of path of the molecules" as defined by the kinetic theory of gases; the co-efficient is also inversely proportional to the pressure. Second, the absolute value of the co-efficient of sliding friction is found to be $0.7 \times l$, on the assumption that the molecule of gas is reflected from the moving surface used in the apparatus with velocities of translation equal to those of the surface itself. For air at 760 millimeters, $l = 0.000083$ millimeter, therefore the co-efficient of friction should be 0.000058 × pressure; but actual observations give a result very nearly twice as great. Hence it is concluded that in the striking of the molecules against the walls, their velocities are not completely equalized. The absolute co-efficient of friction for the air is given by these authors at 0.000189, being exactly midway between the four previous determinations made by Graham, Maxwell, Meyer, and Puling. The co-efficients of friction for hydrogen and for carbonic-acid gas were determined by them to be respectively 0.488 and 0.806 (that of the air being 1), agreeing closely with the values deduced from the observations of Graham. The co-efficient of friction for pure steam at a temperature of 15° Centigrade resulted about one half of that of air. The investigation into the dependence of the co-efficient of friction on the density or barometric pressure of the gas shows that the diminution of friction with pressure is greater the rarer the layer of gas. Further experiments bearing upon the kinetic theory of gases were made by Messrs. Kundt & Warburg in that they attempted to determine the co-efficient of conductivity for heat. Their approximate result for the atmosphere is one eleventh less than that deduced a few years ago by Stefan; and from these same observations there resulted also the value of the radiating power of glass, which agreed nearly with that of Lehnebach. The variation of the radiating power with the temperature does not seem to them to have been reliably determined in the classical work of Dulong and Petit.—*Monatsbericht der K. Akademie von Preussen, Berlin,* 1875, 160.

THE CONNECTION BETWEEN FLUORESCENCE AND ABSORPTION.

Dr. Sorby, President of the Royal Microscopic Society, states that he has been surprised to find that some of those who have paid considerable attention to such subjects have so far misunderstood the question as to suppose that the light of fluorescence consists of rays which are, as it were, reflected by this solution, and do not penetrate through it, so that the spectrum of the fluorescence would show a bright band in the same place as some dark bands seen in the spectrum of the transmitted light. This is certainly an error, and his own observations agree more nearly with Lubarsch, who shows that of eight different substances the spectrum of the light of fluorescence extends some distance on the red end side of the principal absorption band in the spectrum of transmitted light; so that the spectrum of fluorescent substances can never contain rays which are more refrangible than those which are most readily absorbed by a very dilute solution. This, although a very general rule, yet has some decided exceptions. In some substances, under strong illumination, the light of fluorescence does contain rays of greater refrangibility than those most readily absorbed by a dilute solution, and extends from the red end a little beyond the centre of the main absorption band. A number of little known and interesting fluorescent solutions are quoted by Sorby in illustration of his remarks.—*Monthly Micr. Journal*, p. 161.

THE ISOCHRONISM OF THE BALANCE SPRING.

William D. Glasgow, in a short article in the *Horological Journal*, on balance springs, states that the isochronism of the balance spring of a watch is a subject bristling with controversy. There are some who say that every spring must be isochronized; others that every length of spring has its isochronous point of suspension; others that mere length has absolutely nothing to do with isochronism. Mr. Glasgow holds that length has every thing to do with it, as shown by his own experiments. Too short a spring, whatever may be its form, will make the short arcs of the balance's vibrations to be performed in a less time than the long arcs. Thus a spring with ten turns may be too short, and will lose in the short arcs and gain in the long arcs. A spring of two turns will be too long, and will describe its longer arcs in too short a period. The best length for a flat spring is, he finds, fourteen turns; but a flat spring, although the most common, is also the worst form, as it does not expand and contract properly. It will assist the action in this spring if it is always a little small, as this gives more freedom to the portion of the coil next to the stud. The Breguet spring, although differing very little in form from the flat spring, is essentially different in action and principle, having perfect freedom to expand in a circle all around. From twenty to twenty-five turns is, he finds, the best length for this spring. According to his experience, the length of the spring, and the length alone, is sufficient to secure perfect isochronism.—*Horolog. Journal, June,* 1875.

THE VARIATIONS OF TEMPERATURE ACCOMPANYING THE DIFFUSION OF GASES.

Professor Dufour, of Lausanne, Switzerland, as the results of an investigation into the variations of temperature which accompany the diffusion of gases traversing partitions of porous earthenware, states his conclusions as follows: When currents of dry air, of hydrogen or of illuminating gas, circulate along the walls of a porous vase, or of a vase which incloses fragments of porous material, they produce a lowering of temperature. The depression diminishes little by little, and finally ceases altogether. When the currents of the same gas, charged with moisture, circulate under the same conditions, there is produced a heating, which also diminishes gradually, and finally ceases. The warming and the heating are more or less considerable, according to the initial condition of the porous vase. The greatest variations are produced when the dry current succeeds to a saturated current, or inversely. These variations of temperature are probably due to the absorption of aqueous vapor by the porous substance, or to the disengagement of this vapor. If the experiments are conducted under a constant barometric pressure, then, when the air on the one side, and the hydrogen or illuminating gas on the other side, are in contact with the two faces of the porous partition, the diffusion which takes place produces a change of temperature, but a change having a different sign on the opposite sides of the diffusing partition. There is a lowering of temperature on the side where the denser gas is found, or, in other words, on the side where the current arrives most abundantly. There is, on the other hand, a rise of temperature on the opposite side. These variations of temperature have been observed when the gases taking part in the diffusion are dry, as well as when they are charged with aqueous vapor. When the gases are employed without drying, and without saturation, the diffusion also evidently occasions the variations of temperature just indicated; but it is probable that this variation is influenced by the presence of the vapor of water. The extent of the variation of temperature which accompanies diffusion is different in different cases, according to the special arrangements of the experiments. It is always greatest when the diffusion is most abundant and most active. We can conveniently explain the facts established by supposing that in the diffusion the gaseous current produces a heating on the side where it comes into the porous partition, and a cooling on the side where it emerges. These currents having an unequal importance, depending on their density, we can comprehend that there is, as a result, a warming on one of the faces, and a cooling on the other face of the partition. When the experiments are made under different barometric pressures, we find that, when the endosmose of a lighter gas is accompanied by an increase of pressure in the porous vase, the temperature varies only very little, and generally augments during the endosmose, while the manometer falls after having attained its maximum, and the pressures tend to equalize themselves, the temperature diminishes more or less rapidly, and by a relatively considerable quantity. When the exosmose of a lighter gas gives rise to a diminution of pressure in the porous vase, the temperature varies only a very little, and more generally diminishes during the exosmose. When the manometer rises after having attained its maximum, and the pressures tend to equalize themselves, the temperature augments more or less rapidly, and by a quantity relatively quite considerable. This change of temperature, when the diffusion is accompanied with a change of pressure, is conveniently explained by admitting that the thermic variation due to the diffusion is conformable to the laws above indicated, and is due (but with a certain retardation) to the variation caused by the compression or the rarification of the gas which surrounds the thermometer. —*Bibl. Univ.*, XLIX., 103.

ATTRACTION, REPULSION, AND RADIATION.

Professor Crookes, whose first interesting paper on radiation was read in 1873, has recently made a second communication on the subject, in which are described certain improvements introduced by him, and new forms of apparatus, which enable the phenomena of repulsion by radiation to be observed and illustrated. A bulb, three inches in diameter, is blown at the end of a glass tube eighteen inches long. In this a fine glass stem, with a sphere or disk of pith at each end, is suspended by means of a fibre of silk. The bulb is then perfectly exhausted and hermetically sealed. Instead of pith, disks may be made of iron, metal, cork, or other substances. The apparatus, when constructed with proper precautions, is so sensitive to heat that a touch of the finger on a part of the globe near one of the disks of pith will drive the index around over a quarter of a revolution, while it follows a piece of ice, as the needle follows the magnet. With a large bulb very well exhausted, a somewhat striking effect is produced. When a lighted candle is placed about two inches from the globe, the glass stem with its pith disks oscillates to and fro through gradually increasing arcs, until several complete revolutions are made, when the torsion of the suspended fibre offers a resistance to the revolutions, and the bar commences to turn in an opposite direction. This movement is kept up with great energy and regularity, like the movements of the balance wheel of a watch, as long as the candle burns. A modification of this apparatus, in which a glass thread is substituted for the silk fibre, allows quantitative as well as qualitative observations. The sensitiveness of the apparatus to heat rays appears to be greater than that of the ordinary thermo-electric multiplier. Thus the obscure heat rays from copper, at a temperature of 100°, after passing through glass, produce a deflection on the scale of 3½ divisions, while under the same circumstances no current at all is detected in the thermo-pile.—*Nature*, XI., 494.

ROOD'S APPLICATION OF ZÖLLNER'S HORIZONTAL PENDULUM.

The paper of Professor O. N. Rood, on the application of the horizontal pendulum to the measurement of minute changes and the diminution of solid bodies, although read in 1874, has only recently been published; and from it we learn the details of the instrument proposed by him as an improvement on Zöllner's horizontal pendulum. This proposed improvement consists essentially in an inflexible rod placed horizontally, and supported in that position in mid-air by vertical wires or springs, stretched in such a manner that the influence of gravity on the rod is no longer sensible, while its motion is entirely under the control of the observer. Professor Zöllner's apparatus was designed expressly to measure attractive forces and slight changes of level. Professor Rood proposes to apply his own similar apparatus to the study of minute changes in the dimensions of solid bodies, for which purpose he gives it such dimensions as to impart to it an unprecedented delicacy. The main difficulty in the use of this apparatus is the fact that it is exceedingly sensitive to the most distant and unseen sources of disturbance. Thus Professor Rood remarks that children, playing at a distance of 360 feet, caused temporary deflections of one or two scale divisions; and similar deviations were caused by the lower notes of an organ in a neighboring church, the middle and higher notes producing no sensible results. These effects upon the apparatus can be eliminated, however, by making a sufficient number of observations, the evils caused by them being only temporary. As usual in all investigations, the effects of temperature are the most insidious.

As illustrating the fineness of the measurements that can be made with the horizontal pendulum, Professor Rood gives some figures showing that the one eighteen-millionth part of an inch becomes a sensible quantity; whereas hitherto, with the best optical and mechanical means, it has been hardly possible to measure the two one-hundred-thousandth part of an inch.—*Am. Jour. Sci.*, 1875, IX., 441.

THE ELASTICITY OF BARS OF ICELAND SPAR.

Dr. G. Baumgarten mentions that a lecture of Professor Neumann on the theory of elasticity, in which he called attention to the interest that would attach to the determination of the co-efficients of elasticity in crystalline bodies, led him to undertake this labor, and that, so far as he knows, his own are, as yet, the first direct observations on the elastic properties of crystals. Voigt, however, has since then investigated the elasticity of the crystals of rock salt. Iceland spar was chosen by Dr. Baumgarten, among other reasons because, in reference to its physical and optical properties, it is better known than almost any other mineral. His determinations of its elasticity were made by measuring the bending of bars of spar, when pressed in various directions, and which had been cut in different directions from the crystal. The bars operated upon by him were two inches long, and had a square section of about the seventieth part of a square inch. He finds that the amount of deflection in the centre of a bent bar is a function of many quantities, but his observations allow him to state, first, that the deflection of a bar whose section is a perfect square is the same, no matter against which side the bending force is applied. Second, it varies with the dimensions of the bar as regards its thickness, breadth, and length, precisely as though the body were homogeneous; and the same laws apply to it within the limits of accuracy of his observations as apply to ordinary iron bars, the deflections being proportional to the cube, to the thickness, and to the length. Third, the deflection is dependent in a peculiar manner on the direction of the axis of the bar, in relation to the optical axis of the crystal from which it is cut. There exists, however, in this respect no symmetry with reference to the optical axis of the crystal. Bars cut parallel to the longest diagonal of the crystal give a minimum of deflection; those cut parallel to the shortest diagonal giving a maximum deflection.—*Inaugural Diss., Berlin*, 1875.

A NEW MANOMETER.

M. Fol has submitted to the Physical Society of Geneva a description of a manometer specially designed for deep-sea soundings. This instrument consists essentially of two spherical reservoirs, superposed, and connected by a capillary tube. The upper reservoir should be closed and filled entirely with a compressible liquid—for example, alcohol. The other sphere has an opening in its upper part, and is filled with mercury, which also fills the capillary tube. The quantity of mercury which shall have passed from the second reservoir into the first, when the apparatus has been submitted to a given pressure, will give the measure of this pressure, and consequently of the height of the column of water or the depth in the sea.—*Mem. de Soc. d. Phys. de Genève*, 1874, 483.

THE PHYSICAL PROPERTIES OF MATTER IN THE LIQUID AND GASEOUS STATES.

Professor Andrews, in a preliminary notice of his researches on the physical properties of matter in the liquid and gaseous states, says that these investigations have occupied him continuously since 1869. In these he has experimented with gases under a pressure of 500 atmospheres. Of course, great difficulties have been experienced by him in measuring such pressures with accuracy; but the previous difficulties that he has experienced have been, or shortly will be, entirely overcome. His recent experiments fully confirm the conclusions published by him six years ago with reference to carbonic-acid gas, viz., that its contraction under great pressure is greater than it would be if the law of Boyle holds strictly good. Under a pressure of 223 atmospheres, this gas is reduced to $\frac{1}{447}$ of its volume under one atmosphere, being slightly less than one half the volume it ought to occupy if it were a perfect gas, and contracted in accordance with Boyle's law. He infers, by analogy, that the critical points of the greater number of gases not hitherto liquefied are probably far below the lowest temperatures yet attained; and these substances are not likely to be seen, either as liquids or solids, until we can obtain much lower temperatures than those produced by liquid nitrous oxide. Again, the law of Gay-Lussac, like that of Boyle, is true only within certain limits and conditions of gaseous matter; in fact the co-efficient of expansion changes rapidly with the pressure, and if the pressure remains constant the co-efficient changes with the temperature. In reference to the law of Dalton, which is that the particles of one gas possess no repulsive nor contractive power with regard to the particles of another, Dr. Andrews's experiments show conclusively that this is not true; and that the so-called critical point is, for instance, lowered by the admixture of carbonic-acid gas with a non-condensible gas. The law also entirely fails when one of the gases is at a temperature not greatly above its critical point; it only holds good when these gases are at feeble pressures, and at temperatures greatly above their critical points.

ON THE INFLUENCE UPON THE MOVEMENT OF A PENDULUM OF A FLUID CONTAINED IN ITS SPHERICAL BOB.

The illustrious Bessel, in prosecuting his investigations into the force with which the earth attracts various bodies, employed a pendulum having a hollow cylinder of brass as its bulb, in which he placed the various bodies to be experimented upon. His observations gave him the result that the attraction of the earth was the same for all the bodies upon which he experimented; and his determination of the length of the simple seconds pendulum at Königsberg is one of the most correct we possess. He, however, found that when his cylinder was filled with water, the length of the seconds pendulum as computed for that substance was too great. The origin of this deviation Bessel attributed to the fact that the inclosed fluid was by the swinging of the pendulum set into vibrations of its own, whereby its moments of inertia in reference to the axis of vibration of the pendulum was different from what it would have been in the case of a uniform solid body. He accordingly found that the experiments made with long pendulums filled with water showed no such anomaly as in the case of shorter pendulums. Professor O. E. Meyer, well known for his investigations into the friction of gases and fluids, having suggested a somewhat different explanation, his student, Lubeck, has made this matter the subject of an inaugural dissertation, in which he considers the movement of the fluid contained within a pendulum, whose bulb is, for simplicity's sake, a hollow sphere instead of a hollow cylinder, Lubeck shows that the fluid contained in the hollow sphere is not set in motion by its rectilinear movement, but only by its oscillations about the diameter at right angles to the plane of the pendulum's vibration. This oscillation takes place with velocities which are constant for each spherical surface concentric with the hollow sphere, and any initial oscillatory motion is, in a certain time, destroyed by the inner friction, provided that it is originally of the same order as the velocity of the pendulum itself. After this time had elapsed, the motion of the pendulum is quite periodical. The extent of the arc through which the pendulum swings diminishes in a geometrical ratio when the time increases in an arithmetical ratio. The duration of the vibration of the pendulum is greater than if the same pendulum contained within itself a perfect fluid, instead of one having internal friction. The duration of the vibrations is smaller than if the fluid should be replaced by a perfectly solid body. When the length of the pendulum becomes very great the inner friction of the fluid has no perceptible influence on the time of vibration.—*Lubeck's Inaugural Dissertation, Berlin*, 1873.

THE CAUSE OF WOLF IN THE VIOLINCELLO.

Mr. Kingsley, in a communication to the Cambridge Philosophical Society, states that the *wolf*, a name given to a well-known defect in the violin, occurs somewhere about low E or E flat, and has been attributed to the finger-board having the same pitch, so that it becomes, as it were, a portion of the string stopped down on it, and vibrates with it. Another explanation is given by Savart, viz., that the violincello is constructed of such dimensions that the mass of air included within the instrument resonates to a note making 85.33 vibrations in a second, a number which formerly represented the lowest F on the C string; but which now, owing to the rise of pitch since the beginning of the eighteenth century, nearly represents the note E immediately below it.—*Nature*, XII., 40.

THE PYROPHONE.

In 1873 Mr. Kastner brought forward his new invention, the pyrophone, which consists essentially of a flame of hydrogen gas, burning within a tube in such a way as to produce the well-known singing sounds on a large scale. If in the tube of glass or any other material, we introduce two or more isolated flames of proper size, and if we place them at a distance from each other one third of the length of the tube, these flames will vibrate in unison. This phenomenon is produced as long as the flames remain separated, but ceases as soon as the flames are brought into contact. It is upon this principle that his pyrophone is based; and the principal objection to the original instrument, which consisted in the necessity of employing hydrogen gas, he has recently overcome, and states that he is now able to employ ordinary illuminating gas; but to do this he is obliged to eliminate the carbon, whereas at first it was impossible to make the tube vibrate with illuminating gas, although the flames were placed in the proper position. According to him, sonorous flames of illuminating gas are in fact enveloped by a photosphere which does not exist when the flame is simply luminous. This photosphere contains a detonating mixture of hydrogen and oxygen, which determines the vibration of the air in the tube. In order that the sound be produced in all its intensity, it is necessary and sufficient that the number of detonations produced by the molecules of oxygen and hydrogen in a given time shall be in accord with the number of vibrations corresponding to the sound produced by the tube. He finds it sufficient then to increase the number of his flames, substituting four, five, six, or more jets of illuminating gas for his two jets of hydrogen, and diminishing the height of these flames correspondingly, until the sum total of the surfaces of the photospheres suffices to produce the vibrations of the air in the tube.—*Bull. Hebd.*, 1875, 266.

RELATIVE EFFICIENCY OF VARIOUS FOG-SIGNALS.

The principal instruments employed on the American coast as fog-signals are the Daboll reed trumpet, the locomotive whistle, and the siren. In a report on the relative efficiency of these instruments, General Duane states in reference to all of them that, while they are frequently heard at distances of twenty miles, yet as frequently they can not be heard a distance of two miles, and this with no perceptible difference in the state of the atmosphere. It is therefore very difficult to determine the relative powers of fog-signals, unless they are placed side by side, under exceptionally favorable atmospheric circumstances. The sound from the whistle is equally distributed in all horizontal directions, and is most powerful in a horizontal plane passing through the whistle. The sound from the siren is most distinct in the axis of the trumpet with which it is provided. The sound given by the Daboll reed trumpet is usually strongest in a plane perpendicular to its axis. In the average of a great number of experiments, General Duane concludes that the powers of the first-class siren, the 12-inch whistle, and the first-class Daboll trumpet may be expressed by the numbers 9, 7, and 4. The extreme limit of the *audibility* of the sound of the trumpet is twelve miles; that of the 12-inch whistle about twenty miles. That of the siren has not been ascertained. The relative *expenditure of fuel* by the steam-engines working these instruments at their full capacity is, for the siren, 9; the whistle, 3; and the trumpet, 1. As regards the skill and attention required in the management of these signals, the siren seems to require the most, while the steam-whistle gives the least trouble. As to the anomalies observed in relation to the penetration and direction of sound from fog-signals, General Duane holds that they are to be attributed mainly to the want of uniformity in the surrounding atmosphere, and that snow, rain, fog, and wind have much less influence than has generally been supposed.—*Rep. Light-house Board*, 1874, *Appendix*.

FOG-SIGNALS.

In the appendix to the recent report of the Light-house Board, Professor Henry gives the first account that has, as yet, appeared of the experiments and observations made by him in reference to fog-signals, and especially in reference to the acoustic phenomena exhibited on a large scale in the atmosphere. Among other matters, he states that Professor Bache adopted a very ingenious plan for an automatic fog-signal, which consisted in taking advantage of a conical opening in the rocky coast, generally designated as a blow-hole. On the apex of this hole he erected a chimney, which was terminated by a tube surmounted by a whistle. By this arrangement a loud sound was produced as often as a wave entered the mouth of the indentation. The penetrating power of the sound was, under favorable circumstances, due to the pressure of a column of water twenty feet high, giving a pressure of about ten pounds to the square inch. The effect of the percussion, however, sometimes added considerably to this. In practice it was found that this arrangement, which continued in operation for several years, did not entirely supersede the necessity of occasionally producing sounds of greater power. It is stated that Professor J. H. Alexander, of Baltimore, in his investigations on the use of the locomotive steam-whistles, experimentally demonstrated that the power of the sound depends upon the pressure of the steam in the boiler, and the pitch of the sound depends upon the distance between the edge of the whistle and the circular orifice through which the steam issues. Among the various steam fog-signals, one consisting of a double whistle, improperly called a steam gong, seems of interest. This consists of two bells of the ordinary steam-whistle upon the same hollow axes, mouth to mouth; the upper bell has a length of axis of twenty inches; the lower whistle is of the same diameter, but of a length of axis of fourteen inches. The note of the shorter bell is a fifth of that of the longer. This arrangement gives a melodious sound, unlike that of ordinary locomotive whistles, and on that account has extraordinary merit; its character being strongly distinct from that of steamboat whistles. In reference to the audibility of signals in different kinds of weather, it was found that a sound moving against the wind, and inaudible to the ear on the deck of a schooner, was heard by ascending to the masthead. In general, it was stated that when the fishermen in the morning, on the Banks of Newfoundland, hear the sound of the surf to the leeward, or from a point toward which the wind is blowing, they take this as an inevitable indication that in the course of from one to five hours the wind will change to the opposite direction from that in which it is blowing at the time. General Duane states that the fog-signals at Cape Elizabeth, and at Portland Head, which are respectively nine and four miles southeast of Portland, can be heard in the latter city much better during a heavy northeast snow-storm than at any other time, although the sound comes to the city in nearly direct opposition to the course of the wind. The most perplexing difficulty, however, arises from the fact that the signal often seems to be surrounded by a belt in which the sound is entirely inaudible. Thus, in moving directly from the station, the sound is audible for the distance of a mile, is then lost for about the same distance, after which it is again distinctly heard for a long time. This action is common to all sound signals, and has been at times observed at all the stations; even at one where the signal is situated on the bare rock, twenty miles from the mainland, with no surrounding objects to affect the sound.—*Rep. Light-house Board*, 1874, *Appendix.*

ON CELESTIAL PHOTOMETRY.

Professor Thury communicates to the Physical Society of Geneva a very full description of a new photometer adapted to astronomical purposes, and also some general considerations upon photometry. It is not at present necessary, as it was fifty years ago, to insist upon the importance of photometric observations in astronomy. We know that the problems of the distribution of the stars in space, and the gradual modifications that celestial bodies undergo in their own nature, are intimately connected with the intensity of the light we receive from them or that they send out; but it would be impossible to find a collection of photometric observations sufficient to serve as a basis for safe deductions. Either the accuracy of the observations is too small, or there are not enough of them. The observations that we have are due, for the most part, to experienced observers, and the differences between their methods of research fully explains the diversity of their results. In order to make their observations comparable with each other, and to eliminate causes of error peculiar to each method, it is necessary to institute comparative observations by making use of each of the methods employed hitherto in photometry. The results of such an investigation, which has already been commenced in Germany, will probably be, first, a general accordance of the figures obtained by different methods, sufficient to give confidence in their exactness. Second, the knowledge of the means proper to bring about such an accordance; that is to say, a knowledge of the universal corrections and of the improvements necessary to be introduced into the apparatus, and the methods of employing it. Finally, we shall know which of the photometric methods permits the greatest degree of exactness, and which offer special advantages. In general the photometers hitherto employed may be divided into two categories: First, those where the object affected by the light is the eye itself. Second, the physical and chemical photometers, where some inert body is modified by the light. Of these latter, that of Leslie and the photographic photometers are instruments especially adapted to measure separately the intensity of different kinds of radiations. Visual photometers are divided into two classes. In one we diminish the brightness of the light until it disappears from the sight, or, rather, until it becomes too feeble to enable us to distinguish certain definite details of objects, and we then calculate the quantity of the diminution by knowing the methods employed to produce it. These are the photometers of extinction; such are those of Arago, Xavier, and Maistre. The second class of visual photometers is that of comparison, where the two lights present themselves at the same time to the eye, and we diminish the brighter one until it becomes of equal intensity to the feebler. The quantity of this diminution measured as a fraction of the primitive intensity expresses the comparative brightness of the two lights. In place of estimating directly the equality of the brightness of the two images, we can oppose them one to the other, giving birth to phenomena such as will render their perfect equality more sensible—for example, by transforming and transmitting the inequality of intensity into the production of color. The photometers of comparison which possess the greatest perfection can perhaps be called photometers by opposition; such are those of Wild, Bunsen, Dove, and one of Arago's photometers. The essential part common to all photometers by comparison and by extinction is that which is designed to diminish the intensity of the light, under the condition that the quantity of this diminution shall be exactly measurable. To this end, recourse has been had to the eight following methods: First, the absorption of the light by an apparently transparent medium of variable thickness. Second, reflection from a polished surface at a variable angle. Third, reflections from one, two, three, or more surfaces respectively, at an invariable angle. Fourth, the reduction of the intensity by a deviation by means of reflection of a portion of the light. Fifth, reduction of the intensity by two polarizing systems or planes of polarization by inclining them to each other at an invariable angle. Sixth, reduction by bifurcation of the ray in a double refracting prism. Seventh, reduction by the increasing separation of the rays of a conical pencil. Eighth, exclusion of a portion of the beam of light which enters the pupil of the eye. This exclusion may be accomplished by means of a diaphragm placed either near the eye or in front of the objective of the telescope, or within the terrestrial telescope at the place occupied by the small diaphragm of the quadruple ocular. Of all the combinations that we have enumerated, Thury has chosen one of the most simple, viz., a photometer having a variable diaphragm and reflecting mirrors. His instrument is adapted to a four-and-a-half-inch refractor of excellent defining power, and has since 1868 been applied especially to the nebulæ and the components of double stars. The photometric system adopted is, therefore, that of the visual photometer by extinction. The enfeebling of the light is obtained by reflection from one or more mirrors situated between the objective and the ocular, and by a diaphragm having a variable opening placed in front of the objective. This diaphragm is composed of sixteen thin rectangular plates, sliding simultaneously and uniformly each in the direction of its length, and the direction of the radius that passes through the centre of the objective. The polygon of a variable diameter and symmetrical form is the real aperture of the objective. When the aperture of the telescope is diminished too much, the dimensions of the false disks of the stars increase, and the diffraction rings that surround the false disk become so modified that the conditions of visibility are no longer the same for two stars viewed with very different apparatus. It is necessary, therefore, to correct this source of error by diminishing the brightness of the brightest stars, not by contracting the aperture, but by introducing the use of mirrors. A comparative table is given, showing the relative effects of mirrors and diaphragms. Two classes of scales have been adopted in expressing the orders of brightness of the stars. The photometric scale of Sir John Herschel was based upon the simple fact that the intensity of light diminishes as the square of the distance. The brightness of the stars belonging to the first, second, third, etc., magnitudes on his scale was therefore respectively one quarter, one ninth, one sixteenth, etc. The system more generally followed is such that the brightness of a star of any order is always a certain constant fraction of the brightness of a star of the next succeeding order, so that the arithmetic series of magnitudes corresponds to a geometrical series of intensities. The constant ratio in this system would naturally be so chosen as to change as little as possible the magnitudes that have been somewhat arbitrarily assigned to the stars by many generations of astronomers. The actual photometric series of Sir John Herschel accords remarkably well with the ordinary scales of magnitudes, if we simply multiply his magnitudes by 1.41, and take for the unit of intensity a star equal to that of Alpha Centauri. But the photometric scale of this astronomer offers grave inconveniences, which have hitherto prevented its being adopted. The smallest star visible in the twenty-foot reflector of Sir William Herschel, and which is at least of the twentieth order of magnitude according to the scale used by this astronomer, belongs in fact to the three hundred and twentieth order of magnitude on the photometric scale. The geometric scale offers none of these inconveniences, although, on the other hand, it leaves something arbitrary in the choice of the constant factor of the progression. In both scales the standard of magnitude must be adopted as the fixed point of departure; this is an arbitrary point, whose selection demands much careful consideration. The choice of this unit of brightness may depend upon the following considerations: First, it may be a star of invariable brightness (if such exist). Second, it might be an artificial light, if we take means at hand for producing a light of constant value. Third, it may be determined by the effect upon either the eye itself, or upon the inert bodies that are employed in the photographic process. As regards the eye, it should be remembered that the image found upon the retina depends upon the more or less perfect adjustment of the eye of the observer, and, second, that the aperture of the pupil is variable within very considerable limits. These two latter sources of uncertainty may be remedied by simple means, when it will be found that it is highly convenient to adopt as a standard the faintest stars visible to the normal eye. This unit having been determined by many observers for many stars, the average of all will be a unit representing the average sensitiveness of the human eye, and independent of fluctuations in the brightness of the stars, and which therefore is sensibly constant.—*Bibliothèque Universelle*, 1874, 209.

FLOW OF AIR THROUGH ORIFICES.

An extensive series of observations has been made upon the flow of air through orifices, and its discharge under great pressures, by Professor Fliegner and Dr. Zeuner, of the Polytechnic School at Zurich. The velocity of discharge can be obtained theoretically from the kinetic theory of the constitution of gases, according to which theory the molecules are, at relatively great distances from each other, moving in straight lines, except when they impinge on each other, or on the walls of the contained vessel, in which cases they rebound as if perfectly elastic. Applying the formula thus deduced theoretically to the observations made by Zeuner, Weisbach, and Fliegner, it seems to result that, for the atmosphere, the "co-efficient of discharge," as determined by Weisbach, is equal to the "exponent of discharge," as that term is used by Zeuner, and is represented by the number 1.41. In the investigations of this latter physicist, certain resistances have been taken into account, such that, in general, the co-efficient and the exponent of discharge will be different for different fluids. It is in those cases in which the internal resistance or viscosity of the fluid is 0 that the co-efficient and the exponent of discharge become equal.

THE INVISIBILITY OF MINUTE BODIES.

The invisibility of minute bodies subtending a sufficient visual angle to be readily seen if properly defined, is a highly curious and important fact. This depends upon several causes that have been examined by Dr. Pigott, in a paper lately read before the Royal Microscopical Society. Minute bodies are often solely distinguished by the sharpness and decision of their outlines. The question is, can this outline be altered by the conditions of vision, or by any relation between the refractive index of the substance and the aperture of the objective? In examining minute globules of glass, or minute spherical bubbles within a larger mass of glass, we notice a very perfect picture of such objects as are beyond the globules, and the whole surrounded by a black band. The field of view is found to be precisely three fifths of the diameter of the bubble; the breadth of the band being the same when we look at the bubble for all objectives, whatever may be the aperture; but when we look at a solid spherule, we find that the breadth of the band increases from nothing up, until it occupies the whole spherule as we diminish the aperture; the angular aperture at which the black band first appears varies with the refractive index of the glass bead. It results from these observations that the aperture of the objective regulates the appearance or disappearance of the circular black outline of minute refracting spherules, or the black bands of refracting cylinders. It thus appears that the aperture of the microscope objective must be adapted to the refractive index of the substance under examination, in order that we may be able to distinguish minute spherules, cylinders, or other bodies from each other. In the course of his paper, Mr. Pigott states that no glass yet constructed, whether microscopic or telescopic, has been adequate to present to the eye the real size of the image of the sun reflected from a small spherule. With a telescope, the disk, which ought to be the $\frac{2}{1000}$ of an inch, appears something like the $\frac{1}{40}$ of an inch in diameter, or the spurious disk is five hundred times larger than the reality. He concludes from many careful experiments that microscope object-glasses are more finely constructed than the telescopic, but that great improvements are still necessary in that direction.—*Monthly Microscopic Journal, Feb.*, 1875, 55.

RECENT IMPROVEMENTS IN THE MICROSCOPE.

The President of the Royal Microscopic Society, in his late anniversary address, states that the past year has been marked with decided improvements in the construction of microscope object-glasses. A remarkably fine one-eighth inch has been made by Messrs. Powell & Lealand. The image borne by this lens bears amplification by deep eyepieces exceedingly well. Mr. Wenham has constructed a one-seventh inch on an improved formula, obtained by substituting two plano-convex lenses for the single plano-convex posterior lens originally employed. The new lenses are superior in definition, and far superior in clearness and absence of fog or milkiness, to any other objective known to him. As regards fog, this defect is very conspicuous in the one-sixth inch made by Ross, which is constructed of a single front lens followed by three cemented combinations. There are some reasons for surmising that fog is partly due to the multiplication of cemented contact surfaces; and if this be so, the general principles of analysis would lead to the conclusion that the amount of the defect in question would be in proportion to the square of the number of cemented surfaces. Thus, this one-sixth inch of Ross, which has four cemented surfaces, might be expected to present four times as much fog from that cause as the one-seventh inch recently made by Mr. Wenham, which has only two cemented surfaces.—*Monthly Microscopic Journal*, 1875, 98.

TESTING MICROSCOPE OBJECT-GLASSES.

Dr. Pigott advocates the method of testing the object-glasses of microscopes by examination of the miniatures reflected from small globules, especially the examination of the sun's image as seen reflected in small globules of mercury. In this method, an object-glass of fine quality is screwed into the sub-stage of the microscope in an inverted position. On black velvet there are scattered, from a syringe containing mercury, a number of mercurial globules; then, by means of a prism, a brilliant light is thrown vertically downward upon them. The object-glass to be tested is now screwed to the nose of the microscope. The two objectives are brought to a central position, so that their axes coincide, and the instrument is then adjusted to form miniatures of the globules for examination. The most beautiful effects are seen under sunlight. The miniatures develop appearances of marvelous beauty and variety. The aperture of the miniature-making objective should be at least as wide as the objective to be tested, and the lens of the finest quality obtainable. Among the innumerable illuminated objects that may be used, Dr. Pigott strongly recommends what he calls the fundamental experiment; that is, a disk of intense light as small as possible, viewed from a distance sufficiently great to develop the test diffraction rings. It is well known that the surface of the illuminated globules of mercury becomes more nearly spherical as they diminish in weight. The law of the curvature of these surfaces dependent upon the specific attraction of mercury has been investigated by Professor Bashforth, though not yet published. Under direct illumination, a minute spectrum of the sun may be described. The symmetry, beauty, and fineness of refraction rings exhibited by these miniatures from illuminated globules of mercury are severe tests of the objective, and afford delicate means of adjusting its corrections.—*Monthly Microscopic Journal*, 1875, 147.

ACCIDENTAL OR SUBJECTIVE COLORS.

Mr. Plateau states that observations made by himself upon a number of persons of his own acquaintance have shown him that it is impossible to adopt the principle that the accidental or subjective color observed when we cease contemplating a bright object has always a tint complementary to that of the object itself. This subjective tint depends upon the eyes of the observer; and the cases where the principle is satisfactory constitute rather the exception than the rule, at least so far as concerns blue and yellow. Therefore, in a recent communication to the Belgium Academy, he says that he must continue to maintain the general theory, with reference to accidental colors, that he published forty years ago, and which he thinks has not been sufficiently considered by recent authors. His theory consists essentially in the following propositions: First, during the contemplation of a colored object, the retina exerts an increasing reaction against the action of the light which falls upon it, and tends to throw itself into an opposite state. Consequently, after the disappearance of the object, it takes spontaneously, or, as it were, by inertia, its opposite state, whence results the sensation of the accidental or subjective color. Then it comes to repose by a sort of oscillation, in virtue of which it passes alternately from the accidental to the complementary tint, and *vice versa.* The physiological condition of the retina after the prolonged action of light is very nearly like the state of a body which, drawn from a position of stable equilibrium, then abandoned to itself, returns to repose by a series of decreasing oscillations. Second, analogous phenomena take place in reference to space; while one portion of the retina is submitted to the action of a colored light, the surrounding portions throw themselves into the opposite state; whence results, all around the colored image, an aureole of the accidental colors, and, finally, beyond this aureole there is a tendency toward a manifestation of a cloudiness of the same tint as that of the primitive image. Such a state of the retina can but be compared to that of a vibrating surface, in which the nodal lines are separated by vibrations in opposite directions. This theory has, he says, been adopted in France, but is quite rejected by the German and English physicists. He has been so occupied by his extensive researches into the phenomena of thin liquid films that he has not until lately found time to defend his theory. In the memoir in question he adduces numerous observations tending to disprove the theories of Scherffer, and of those who have followed him, as also the theories of Thomas Young and his followers.—*Bull. Ac. Roy., Belgique*, 1875, 100.

REFLECTION OF THIN FILMS.

Govi has made a happy application of that principle in optics by which thin films can at the same time reflect and transmit rays of light according to their angles of incidence. He applies a film of gold to the hypothenuse of a right-angled prism of glass; the film allows direct rays to pass through the prism, while the latter reflects the oblique rays coming through the microscope. By placing this prism obliquely upon the ocular of a microscope, the magnified image is reflected upon a sheet of paper, where it can be drawn by the observer who looks through the gold film.—*Rev. Sci.*, 1874, 167.

SIEMENS'S ELECTRICAL PYROMETER, AND DIFFERENTIAL VOLTAMETER.

We had occasion some years ago to give some account of the very elaborate investigations made by Weinhold in reference to the reliability of the various methods employed for measuring very high temperatures accurately, and to call attention to the fact that his researches fully substantiated the claim of Dr. Siemens that the electrical pyrometer, as constructed by him, was a thoroughly reliable instrument. It is now a pleasure to be able to refer to the very important memoir of Dr. Siemens himself, just published in the *Journal* of the Society of Telegraph Engineers. This memoir, which was in part delivered as a lecture in 1871, has been delayed in its publication, owing to the innumerable interruptions experienced by the author in consequence of his professional duties. The fullness of its details shows how large a series of experiments Dr. Siemens undertook to satisfy himself of the accuracy of his method of measuring temperatures.

His memoir consists, first of all, of a very suggestive chapter on the influence of temperature upon the electrical resistance of metallic conductors, which he expresses as a function not only of the temperature reckoned from the absolute zero, but, first, of the co-efficient of increase peculiar to the particular metal under consideration; second, of the co-efficient of increase dependent upon the co-efficient of the expansion of the metal; and, third, of a function of a co-efficient expressing the resistance of the material at the absolute zero. He finds his formula correctly applicable to the metals platinum, iron, copper, aluminum, and silver, at temperatures between zero and 350° C. The results of his experiments are given in detail, and afford a valuable basis for still further investigations.

In the second part of his memoir he states that, in 1860, when engaged in examining the electrical condition of the Malta and Alexandria telegraph cable, his attention was directed toward the fact that the increase in the temperature of the cable could be measured by the increasing resistance to the electrical current; and accordingly constructed coils of cable wire, of known electrical resistance, inclosed hermetically in iron tubes, out of which passed thick insulated wires; and placing these coils at various points within the mass of the cable, he was able, by examining the varying electrical resistances, to ascertain that the interior of the large mass of coiled cable was steadily rising in temperature, and by pouring cold water thereon saved it from ultimate destruction. Following up this idea, he shortly afterward constructed thermometer coils, consisting of a spiral or insulated wire, inclosed in a cylindrical silver casing, which he used for measuring ordinary temperatures on land, and which could be used, he suggested, by physiologists and others. The instrument is extremely sensitive, being correct within one tenth of a degree Fahr., or even less; and a modified arrangement of this kind for measuring deep-sea temperatures was presented to the Berlin Academy in 1863. After describing the method adopted by him for determining the temperature of a distant spot, and also a similar apparatus furnished by him to the steamship *Challenger* in her exploring expedition, he gives in detail the method of construction of the pyrometer for measuring high temperatures. He states that Professor Bolzain, of Kasan, is at present employing his resistance thermometer for registering the temperatures below the surface of the earth, and measuring the temperature of the air above; and, furthermore, that Mr. Bell, the eminent metallurgist, habitually employs his pyrometer for the determination of the temperatures employed in various operations of the blast furnace.

The third part of Mr. Siemens's paper is a highly suggestive and valuable memoir on a simple method of measuring electrical resistances. He states that although a Wheatstone balance furnishes electricians with the means of measuring the resistances of electrical circuits with great accuracy, yet its application is, in many cases, rendered difficult on account of the delicacy of the apparatus and of extraneous disturbing causes. As a portable instrument, and one especially applicable to observations on shipboard and in exploring expeditions, he proposes what he calls a differential voltameter, which consists of two similar narrow closed tubes fixed vertically to a wooden frame, with a divided scale behind them, and whose lower ends, being enlarged somewhat, are fitted with wooden stoppers saturated with paraffin, and penetrated by platinum wires. Diluted sulphuric acid is admitted into these tubes, and kept at a proper height in each by a very simple device, and the evolution of gas that occurs, when a current passes from the electrodes, affords the measure of the strength of the current. By means of a commutator the current from the battery is easily reversed every few seconds, preventing polarization of the electrodes. By introducing the resistance of the voltameter, and the unknown resistance *x*, first on one, and then on the other side of the arrangement, the observations, by a simple arithmetical process, give the exact value of the unknown resistance. The measurement of the quantity of decomposed gases serves merely to determine the relative intensity of the currents which flow in the respective positions of the commutator. He states that, having measured numerous resistances by this instrument, and compared the results with measurements obtained by a very perfect Wheatstone bridge arrangement, he finds that it may be relied upon within a half per cent. of error of observation. The instrument especially recommends itself for use on board of vessels, as not being in the slightest degree influenced either by the motion of the vessel or by the magnetic influence of moving masses of iron. One of its intrinsical advantages is that it gives the resistance to be measured in units of work done, independent of such momentary changes in the strength of the current as affect the readings of a magnetic needle. It is also portable and inexpensive.—*Jour. Soc. Teleg. Engineers*, 1875, 296.

THE ACTION OF AN ELECTRO-MAGNET UPON THE SPECTRA OF RAREFIED GASES TRAVERSED BY ELECTRIC DISCHARGES.

M. Cheautard states that he has examined the spectra of rarefied gases illuminated by an electric spark, and subjected to the influence of powerful magnets, and finds that these spectra are characterized as to the position, the number, the separation, and the fineness of their lines by very curious traits peculiar to each gas. As regards the metalloids with which only his experiments have thus far been conducted, he states that the light given out by sulphur and by selenium experienced a notable diminution under the influence of the magnet, so that sometimes the spectrum, which was very apparent at first, disappeared for some moments. On the contrary, chlorine and bromine are characterized by an increase in brilliancy, and by the development of fine brilliant rays especially numerous in the green, whose appearance or disappearance at the moment when we turn on or interrupt the current has a truly magical effect. This phenomenon seems to have some importance in consideration of the obscurity which at present characterizes our knowledge of the relation of magnetism and light.—1 *B*, 1875, 283.

THE FREEZING OF SALT WATER.

Professor Guthrie, in continuation of former researches on the solutions of salt, has endeavored to ascertain the manner in which mixtures of salt act as cryogens, and to study their combination with water at various temperatures and in various proportions. He finds that when two salts, composed of different acids or bases, are mixed, and no precipitation occurs, it is generally considered that partial decomposition takes place, two new salts being formed; but he finds that if the salts $a\ x$ and $b\ y$ be mixed in atomic proportion, and dissolved in the smallest possible amount of water, a mixture is obtained identical with that produced on mixing $a\ y$ with $b\ x$; and the temperature and composition of the resulting cryohydrate are the same in both cases. Thus, a saturated solution of a mixture of nitrate of potassium and sulphate of sodium solidifies at —5°. A mixture of nitrate of sodium and sulphate of potassium also solidifies at this temperature; but the temperatures never fall as low as the point which could be reached by employing whichever of the salts *a x*, *a y*, *b x*, or *b y* forms a cryohydrate with the lowest temperature. Thus, in the above case, the solidifying point of nitrate of sodium is —17°.—*Nature*, XI., 440.

ON UNILATERAL ELECTRIC CONDUCTIVITY.

Dr. Arthur Schuster states that in the course of many experiments he has had frequent occasion to remark that electric currents seem to traverse copper wires more easily in one direction than in the other; so that the galvanometer indicates different intensities when we reverse the direction of the current which traverses it. He gives to this phenomenon the name of unilateral conductivity. He first observed it in using the galvanic battery, but was able to make more accurate observations by means of magneto-electric machines. The phenomenon observed with this apparatus led him to the hypothesis that the current induced by one pole of the magnet traverses a circuit more easily than that induced by the opposite pole. In his second memoir Schuster records another phenomenon which is not without analogy with the preceding. He joined the electrodes of a galvanic battery to the apparatus which he had used in his first experiment, and found that, whatever the intensity of the continuous current might be, or the relative positions of the electro-magnet to the battery, it always happened that the initial deviation of the galvanometer needle augmented during the rotation of the magnet. On the other hand, as long as the magnet was immovable, it exerted no influence upon the deviation produced by the permanent currents. Noting then, at first, the initial deviation of the needle while the magnet was stationary, he interrupted the current before turning the magnet, and observed again the deviation produced at the first passage of the current during the rotation. The difference between these two deviations was sensibly proportional to the intensity of the permanent current, but decreased rapidly with the increase in the electric vibrations produced by the magnet. The cause of this singular influence of the rotation of the magnet upon the intensity of the permanent current is scarcely less obscure than that of the unilateral conductivity; and the explanation of the one phenomenon involves the apparent contradiction of the other.—*Bull. Hebd.*, 1875, 297.

SINGULAR PROPERTY OF ALUMINUM ELECTRODES.

A singular property of aluminum has been noticed by Ducretet. A voltameter, whose electrodes are respectively aluminum and platinum, allows an electric current to pass, or prevents it, according as the electrodes are respectively positive or negative. If the positive current passes from the platinum to the aluminum, no unusual resistance is experienced. If, on the other hand, a positive current passes from the aluminum to the platinum, the current is nearly arrested, and the needle of the galvanometer marks in the first case, for instance, 22°, and in the second case 2° only. The explanation of this seems to be that in the former, or favorable case, the current disengages oxygen at the platinum and hydrogen at the aluminum pole. But in the oppesite case the oxygen is produced at the aluminum pole, and forms a layer of alumina (or the oxide of aluminum), to the presence of which the arrest of the current must be attributed. If the poles are placed in hydrochloric acid, the phenomenon no longer takes place, and similarly does it not follow if we employ any alkaline liquid. In opposition to this explanation, however, it must be granted that the microscopic examination of the aluminum electrode does not reveal any apparent change in its appearance, no matter in which way the current flows. Whatever may be the explanation, the fact remains, and is certainly a very striking one. Of course, if both electrodes are formed of aluminum, the current will not flow in either direction. Ducretet proposes to apply this interesting property of aluminum in the construction of a telegraphic apparatus, which he calls a rheotome of constant direction.—13 *B*, III., 218.

ON THE ELECTRIC DISCHARGE.

The electrical sparks of a peculiar nature that have been called "feeble sparks" by Riess, by whom they were first discovered, are distinguishable from the ordinary bright sparks, not only by their form, their light, and their noise, but also by other peculiarities, such that a further investigation into their nature has been made by him. Among the isolated points considered in connection with these feeble sparks, Riess states that Wiedemann and Ruhlmann have from special investigations concluded that the quantity of electricity necessary for a discharge is much greater when the discharge takes place from the negative than from the positive electrode. But his own experiments seem to him not to justify so positive an expression, as they can be explained by means of the feeble glimmer that precedes an eruptive discharge. We have, moreover, no experiments which would lead us to think that there is a greater quantity of electricity present in a positive than in a negative spark. From experiments made with the Holtz machine, he concludes that the greater length of the negative electrode is not an important condition in producing feeble sparks, but that in these experiments electrodes may be employed of any length whatever. The feeble sparks are, not only in reference to their length, but also to their light and brightness, independent of the composition of the arms of the discharger by means of which they take place.—*Monatsbericht der Berlin Akad.*, 1875, 152.

TELEGRAPHIC GROUND CURRENTS.

Speaking of the importance of observing the underground or so-called earth currents on electric telegraph wires, Sir William Thomson states that an observation which would be of value for scientific study is to observe the indication of the electrometer at each end of the telegraph line at any time—whether during a magnetic storm or not—during the day or night. If the line be worked with a condenser at each end, this observation can be made without in the slightest degree disturbing the practical work through the line by simply putting on an electrometer in direct connection with the line, and connecting the outside of the electrometer with a proper earth connection, when it may be observed, quite irrespectively of the signaling, when signaling is done, as it very frequently is, on submarine lines with a condenser at each end. The scientific observation will be disturbed undoubtedly by the sending of messages; but the disturbance is only transient, and in every pause at the end of a word there will be a sufficiently near approach to steadiness in the potential at the end of the wire connected with the electrometer to allow a careful observer to estimate with practical accuracy the indication that he would have were there no work of the line going on at the time. A magnetic storm of considerable intensity does not stop the work—does, indeed, scarcely interfere with the work of a submarine line in many instances—when the condenser is used at each end. Thus observations, even when the line is working, may be made during magnetic storms, and again during hours when the line is not working. Any single observation, or any series of observations, that are made on the electric potentials at one end of the insulated line will give valuable results. When an arrangement can be made for simultaneous observations of the potentials of the electrometer at the two ends of the line, the results will be still more valuable. We may substitute, with satisfactory results, for the electrometer, the galvanometer of very large resistance.—*Jour. of the Soc. of Telegraph Engineers*, III., 1874, 10.

THE ELECTRICAL VOTING MACHINE.

Monsieur J. Morin has presented for inspection a model voting machine constructed for a deliberative body of twelve voters, in which he proposes to simplify, in a considerable degree, the tedious process of voting, and to economize the time of an assembly. To attain this end the machine ought to be prompt and certain, and free from errors as to the result of the votes. It is composed of a portable table, having twelve circular openings, below which are written the names of the members, each opening corresponding, by invisible wires, to the place of the representative named upon the table. Beneath are placed two small openings closed by small covers, which disappear at the end of the operation, so as to allow one to see the number of votes that have been cast for and against the project. Each of the deputies has also two balls, black and white, corresponding to the opening which belongs to him in the table. The operation of the process is as follows: The deputy, by touching a button, draws before the opening placed upon the table and under his name a disk of the same color as the ballot that he wishes to throw, and which closes the opening. By the interior arrangement of the machine, a vote being once made prevents the expression of a second, so that it is impossible to vote twice. When the president is sure that every one has taken part in the vote, he touches a special button placed at the side of the machine, and instantaneously the work of addition begins. In this operation, by an ingenious contrivance, the white balls are separated from the black, and the totals thus formed occupy two appropriate places upon the table. At this moment the little covers remove themselves, and allow one to see the figures resulting from the addition. At the moment when the president sets the process of addition into operation, all voting is suspended, so as not to derange the work. Upon the back of the machine there is a system of needles corresponding to each of the openings, which, as soon as the vote is terminated, prints the result upon a sheet of paper prepared for this. A lateral lever permits the reinstating of every thing in its initial condition, ready for a new operation. All these operations are performed by electricity and instantaneously, and the author says that one minute will suffice to count the votes of an assemblage of seven hundred and fifty persons. The complete machine is now manufactured to order in Paris, the cost being about twenty dollars per voter.—1 *B.*, 1875, 206.

THE THEORY OF THE ELECTRICAL MACHINE.

Poggendorff states that few problems in physics have as yet defied all theories so completely as those offered by the electric machines. Theories there are in plenty; but none explain all the facts, and none are free from unwarranted assumptions. He himself inclines to the opinion that it will not do to assume that the particles of electricity are spherical, and exert their action equally in all directions; but that it is more likely that they are polarized; that they have a definite range on the electrified surface; and that in consequence of the movement of this surface the particles themselves turn. The development of this idea, which is in opposition to the assumption of two electric fluids, as commonly held in Germany, seems, however, to him to be attended with insuperable difficulties. He appears to have been led to this suggestion by observing the effects produced by turning the revolving plate of an electric machine of the second class through measured angles of 45°, 90°, 135°, etc., instead of turning it steadily throughout the entire circumference.—*Berlin Akad. Monatsb.*

THE ELECTRIC CONDUCTIVITY OF LIGNEOUS SUBSTANCES.

Count Du Moncel has investigated the question as to whether the conductivity of wood fibre, if electrified, is due to the humidity with which bodies are more or less impregnated. His experiments, being conducted with extremely sensitive apparatus, have led him to the following conclusions: A small frame of oak, regarded by the cabinet-maker as being very dry, furnished, when it was brought to him, a deflection of 55° of the scale of the galvanometer. This same small frame, when it had been dried for two hours in the stove, gave not the least deflection, and being kept in a sunny chamber for several hours did not increase its conductivity. Exposed to the air during a dry July night, it gave in the morning a deflection of 13°. It appears from his experiments that it is to the humidity aspired through its pores that the wood owes its relative conductivity, and that this conductivity is proportionate to the degree of pressure upon the metallic plates by means of which the electric current is communicated to the block of wood.—*Proc. Soc. Teleg. Engineers.*

CIRCULAR MAGNETIC NEEDLES.

A report has been presented by Duchemin on the experiments made on board of the French vessels *Faone* and *Savoie*, upon the properties of magnetic needles made in the form of a circular disk, instead of a pointed or lozenge-shaped one. Two series of experiments were made: first, with reference to the comparative steadiness of the simple and the circular needles; second, with reference to the correction of the circular needle for local influences by the addition of a concentric movable circular magnet. The sensibility of the circular needle, according to him, leaves nothing to be desired, being superior to that of the ordinary compass, although its friction is greater, since its weight is more than twice as great. The stability of the circular needle, as shown by its oscillations to the right and left, is greater than that of the ordinary needle; and its moment of inertia is, in fact, equal in all positions. No difficulty is experienced in locating the position of the magnetic axis of the circular needle. These needles are magnetized instantaneously by means of a powerful soft-iron electro-magnet. He concludes that the circular compass-needle is an instrument worthy of navigators; and by perfecting its construction we shall come into possession of a simple, sensitive, stable instrument, constituting a veritable improvement on the present arrangement. It is even stated that the extreme sensibility that can be given to this instrument may render it advantageous in magnetic observations. A portion of the errors of the instrument, due to local attractions, may be corrected by means of a circular magnet; but this is not to be recommended, as new complications are thereby introduced.—*Bull. Hebd. Assoc. Scientifique.*

CORRECTIONS OF THE COMPASS ON IRON SHIPS.

From an elaborate memoir, by Garbich, on the theory and practice of the deviation in compasses on iron ships, we take the following directions for effecting the compensation of the compasses. In order to avoid the employment of large masses of iron, it is best to use two iron rods placed diametrically opposite to each other. To determine exactly the distance of these rods from the centre of the compass, it is best to turn the ship's head toward that point in the horizon at which the quadrantal deviation is a maximum, after first allowing for the semicircular deviation; then, by moving the rods to or from the centre of the compass, to annul the maximum quadrantal deviation. This error being thus compensated, it will be found that a portion of the rolling or heeling deviation is also removed. The semicircular deviation is then best compensated, by means of two magnets, as follows: Under the centre of the compass is fastened a non-magnetic metallic parallelopipedon of square section, one side of which is parallel to the keel; the lower side of this should be fastened to a metallic disk of the same material, and this so fastened by screws to the base of the binnacle that its position can not be altered with reference to the keel of the vessel. On the upper end of this parallelopipedon must be fastened a cross-piece, by means of which the whole may be kept always vertical. A steel magnet is provided with a square slit, such that it can be placed any where and in any position upon the parallelopipedon. According, then, as certain co-efficients in the expression for the magnetic disturbance are larger or smaller, the magnet is to be placed either parallel or transverse to the parallelopipedon, and is to be moved up or down until the needle points accurately north and south, when the magnet is to be fastened in that position. The ship is then to be swung, and a third magnet is also to be fastened to the same parallelopipedon in a certain manner described by Garbich, until when the ship heads east and west the needle still points correctly north and south, when this third magnet is to be fastened in its place. With this adjustment the correction of the compass is finished, except in so far as there may still remain a slight error, due to the want of symmetry in the apparatus, and which may be corrected by swinging the ship to the west as well as to the east. In order to compensate for the remaining rolling or heeling deviation, a cylindrical steel magnet, about seven inches long and two thirds of an inch thick, is appropriate, which is to be placed before the needle and inclined to the vertical, at an angle whose tangent is a well-known co-efficient. This compensation becomes of great importance in high latitudes. In passing into magnetic southern latitudes, the vertical compensating magnet must be reversed end for end. The easiest method of directing the ship toward any given point of the horizon will be attained by the use of a compass described by Garbich, combining in itself both magnetic and azimuthal compass, having three concentric azimuthal circles, and which is to be used in connection with the azimuthal tables computed by Labrosse, which give, for every latitude of the ship and every position of the sun, and for every hour of the day between sunrise and sunset, the angle between the meridian and the sun's vertical.—"*Mittheilungen*" *Austr. Hydrog. Office*, 1874, 167, 257, 426.

ANCIENT MUSICAL INSTRUMENT IN CHINA.

Among the ancient musical instruments of the Chinese is the pien king, which is an assortment of sixteen stones arranged on strings in two series of eight each, one above the other, and each giving out, when struck successively, the system of sounds employed by the ancient Chinese in their music. The size and shape of these stones have been very carefully determined by them after a minute analysis of the sounds peculiar to each one. In order to render the sound graver, the thickness of the stone is diminished to the proper amount, and, to render it more acute, something is cut off from the length. The stones thus arranged remind one in effect of a series of steel bars, as exhibited in acoustic apparatus to illustrate the fact that vibrations above a certain pitch are inaudible to the human ear. Frequent endeavors have been made to decide what kind of stones were employed in the fabrication of the pien king, since they were customarily paid as tribute money more than two thousand years before Christ by certain provinces of China. Certain authors have thought that they recognized in them a kind of black marble; and the editor of the works of Father Amiote asserts that the king, or musical stone, constructed in France from the black marble of Flanders, was quite as sonorous as those of China. Lately a discovery was made at Kendal, in England, of some musical stones, which, when struck with a piece of iron or another stone, gave out sounds of very different pitch, and with eight of which it would be possible to attain a very distinct octave.—13 *B*, III., 203.

REMARKABLE IMPROVEMENTS IN STRINGED INSTRUMENTS.

Some very remarkable results of persistent investigation have been just communicated to the Physical Society of London by Mr. Hamilton, of Oxford. In prosecuting these researches Mr. Hamilton has for over two years resigned all other work, and he announces finally that, by means of stringed instruments reinforced by reeds, he has been able to secure for these all the advantages of organ pipes, in addition to those which they already possessed. In short, the strings vibrating on the sounding-board are made to imitate exactly in volume, quality, and sustained sound either an open diapason pipe or the largest organ pipe in use, his hearers being satisfied that not only can a string do all the work of an organ pipe in volume and sweetness, but also afford the exquisite sympathetic and blending power hitherto considered to be peculiar to strings. Another invention of his is a string which, to the great surprise of those who attempted it, could not be put out of tune. Mr. Hamilton is still engaged in perfecting his inventions, which promise to give us the effect of an organ in a piano-forte, and that of a piano-forte in a cottage instrument.—12 *A*, XI., 99.

HARMONY IN MUSICAL INSTRUMENTS.

In a course of lectures on the science of music Mr. Ellis has explained the defects of the ordinary keyed instruments, toned by a system which he characterizes as the worst possible, in that every element of harmony is violated. In the piano-forte the errors of temperament are not so offensive as in the organ and in the harmonium. In olden times organs were tuned on a temperament which put the principal keys in good tune, but more recently organists, having made up their minds to play in all sorts of remote keys, a great change has taken place, and an equal temperament has been attempted. For show organs this course may be defended, but not for church organs, where nothing but the simplest keys are required. The organ of half a century ago was a sweet-sounding instrument compared with the harsh ones of modern days. A curious proof occurred a few years ago of the mischief done to the tone of an organ by the equal temperament. Dr. Pola had to construct two organs of tolerable size. In the one he gave way to popular prejudice by having it tuned equally; in the other he adopted the old tuning; and though the instruments were precisely alike in other respects and made by the same builder, the latter organ acquired the reputation of being peculiarly sweet-toned, while the former was considered harsh.—12 *A*, XI., 89.

D. CHEMISTRY AND METALLURGY.

VANADIUM IN ROCKS.

Vanadium, hitherto regarded as one of the rarest metals, is now said by Dr. A. A. Hayes to be very widely diffused. It occurs as vanadic acid, associated with phosphoric acid, in minute traces in very many of our commonest rocks. In fact, it seems to be almost as frequently met with as manganese. Dr. Hayes has detected it in green and plum colored slates and porphyries, in sandstones, and in various rock aggregates.—1 *A*, *April* 16, 1875, 166.

CRYSTALLIZED CADMIUM.

Hermann Kämmerer has obtained fine crystals of metallic cadmium by distilling the metal in a current of hydrogen in a combustion tube. These crystals were silver white, and seemed to belong to the regular system, there being regular octahedrons, dodecahedrons, and other more complicated forms. The experiment can be performed in the lecture-room before a class.—21 *A*, *May*, 425.

OXIDATION OF RUTHENIUM.

Ruthenium, the rarest metal of the platinum group, differs from its associates in the ease with which it undergoes oxidation. Its properties in this respect have recently been investigated by Deville and Debray, who worked chiefly with the tetroxide, RuO_4. This substance is easily formed by the fusion of ruthenium before the oxyhydrogen blowpipe. The metal then oxidizes almost as readily as antimony, giving off a blackish vapor which smells strongly of ozone. Strangely enough, however, the oxide, although formed at such a high temperature, can not be heated without decomposition. By simply heating a specimen of it to about 108° Centigrade, it can be made to decompose with a very violent explosion, yielding a large quantity of highly ozonized oxygen. These peculiarities seem to distinguish it from all other known oxides.—*Annales de Chimie et de Physique*, *April*, 537.

METALLIC BARIUM.

Although the compounds of barium have been so long and so thoroughly known, the metal itself has been but little studied. Sergius Kern, of St. Petersburg, has lately succeeded in preparing it by several methods in a state suitable for examination. The best process seems to be to heat barium iodide with metallic sodium. A violent reaction ensues, accompanied by an evolution of heat and light; the resulting mass is treated with mercury to form a barium amalgam, from which, finally, the mercury is distilled. The barium so obtained resembles calcium very closely, is apparently tough and ductile, and has a specific gravity of 3.75.—1 *A*, *June* 4, 243.

PURIFICATION OF TIN BY FILTRATION.

Curter has proposed an interesting method of freeing tin from less fusible metals by means of filtration. The filter was constructed as follows: Common tinned iron of ordinary thickness was cut into strips about 150 millimeters long by 100 wide. Five hundred of these, with their surfaces parallel, were wedged together in an oblong iron frame, and this frame was tightly fitted into an opening in the bottom of a large graphite crucible. The tin to be purified was then melted in another crucible, and allowed to cool until crystals began to form on its surface, when it was transferred to the above-described filter. Of course the heat sufficed to melt the tinning of the iron strips, thus leaving narrow spaces between them through which the molten metal could flow, its solid impurities remaining behind. More than fifty centners of impure Bohemian tin was thus rendered almost chemically pure, the iron, copper, and arsenic with which it had been contaminated being left, alloyed with some of the tin itself, upon the filter.—14 *C*, *March*, 469.

THE ARTIFICIAL IMITATION OF NATIVE MAGNETIC PLATINUM.

It is known that occasional pieces of native platinum not only act upon the magnetic needle, but are themselves magnetic, like the true iron magnets. Berzelius and Kokscharof have contributed somewhat to our knowledge of the chemical and other properties of this platinum, and have shown that there is always a certain quantity of iron associated in these specimens, so that Breithaupt has proposed for it the name of iron-platinum. The subject has recently undergone a very thorough study by Daubrée, who from his experiments upon the native material shows that the presence of iron in proper proportion suffices to account for the polarity of the native specimens. He still more firmly establishes his conclusions by artificially producing magnetic platinum, similar to that which occurs in nature. An alloy of 99 parts of iron and one of platinum, after a complete fusion, instead of becoming strongly magnetic, did not give any trace of polarity. Two other alloys, of 75 and 50 parts of iron respectively, behaved in very nearly the same manner. Alloys formed some time ago by Berthier, containing 78 parts of platinum and 21 of iron, although imperfectly melted, are, however, susceptible of magnetism. It appears, then, that however pronounced may be the magnetic power of the iron, the alloys where this metal predominates do not acquire polarity under the same conditions as do alloys obtained with a smaller quantity of iron. Thus an alloy of 17 parts of iron and 83 parts of platinum has very strong magnetic properties, so that we must admit that platinum alloyed with iron in proper proportions becomes exceptionally susceptible of acquiring the magnetic state. In nature this magnetic state would naturally be produced by strong induction, attributable to the magnetic forces of the globe; and Daubrée has therefore, as a last experiment, placed a small bar of the alloy during its fusion exactly in the plane of the magnetic meridian. As soon as it was solidified, it was inclined so as to be parallel to the inclination needle, until its cooling was complete, and it was then recognized that the bar actually presented at its two extremities very energetic magnetic poles, the upper end being the south pole of the needle, showing that the earth's magnetism had actually produced this effect. On heating the same bar to a red heat, and giving it the diametrically opposite position during its cooling, it was found that the magnetism of the bar was reversed by the earth's induction.—*Bulletin Hebdomadaire*, XVI., 40.

PRECIPITATION OF METALS BY ZINC.

Every chemist knows that when metallic zinc is placed in a solution of either copper or silver, the latter metal is precipitated. J. L. Davies has found it to be possible to precipitate nickel in a similar manner, it being necessary, however, to render the nickel solution strongly ammoniacal. The zinc is used in the form of filings, and the nickel is thrown down distinctly metallic and in a weighable condition. The experiments were made with solutions of the sulphate and the chloride of nickel.—21 *A*, *April*, 311.

ABSORPTION OF HYDROGEN BY METALS.

Not long ago Troost and Hautefeuille announced that sodium, potassium, and palladium absorbed hydrogen to form alloys of definite composition. They now present the results of similar investigations with iron, cobalt, and nickel. These metals absorb hydrogen largely, but to different degrees under different circumstances, not forming genuine compounds. Thus an ingot of nickel under favorable conditions will absorb one fifth its volume of the gas. The same metal in an electrolytic film can be made to take up forty volumes, while pulverulent nickel can dissolve nearly one hundred times its bulk of hydrogen. With each of the three above-named metals the pulverulent or pyrophoric modification has the highest absorptive power, and the compact form the lowest. Finely divided iron was found to differ from cobalt and nickel in its power of decomposing water, a phenomenon which takes place slowly at ordinary temperatures, and rapidly at about 100° Centigrade. Iron thus resembles manganese more closely than either of the other metals. — 6 *B*, *March* 29, 788.

OZONE IN THE LIBYAN DESERT.

Professor Zittel, during a recent journey in the Libyan Desert in Egypt, made some observations of atmospheric ozone, from which it appears that the air over the desert is richer in ozone than that at the oases and the valley of the Nile, the ratios being as 73 to 48. The Libyan Desert, therefore, seems to be the richest in ozone of all portions of Europe. The ozone was observed to be always less in the daytime than in the night—greatest during clear weather and with northwest or west winds. Vegetation has been generally looked upon as an important source of ozone, whereas Ebermayer says that in all wooded regions the air in winter is richer in ozone than in summer, and that therefore forests, as such, evidently do not exert any influence through their leaves, but possibly through their greater moistness. Zittel, however, thinks there is no relation between vegetation and atmospheric ozone.—*Zeitschrift für Meteorologie*, IX., 312.

THE PHYSICAL PROPERTIES OF HYDROGENIUM.

The interesting substance known to chemists as hydrogenium has been the subject of some physical measurements by Dewar, who has attempted to make a new determination of its specific heat and its co-efficient of expansion. The only condition under which hydrogenium is known to exist is that of an alloy with the rarer metals, palladium, platinum, etc. As the result of his experiments with palladium and hydrogen, the specific heat of hydrogenium is concluded to be almost exactly 3.4. The co-efficient of cubical expansion appears to be very nearly 0.00025.

THE COMBUSTIBILITY OF IRON.

The following elegant lecture experiment for illustrating the combustibility of iron was originated by the late Professor Magnus, of Berlin. A mass of iron filings is approached by a magnet of considerable power, and a quantity thereof permitted to adhere to it. This loose, spongy tuft of iron dust contains a considerable quantity of air imprisoned between its particles, and is therefore, and because of its comminuted condition, well adapted to manifest its combustibility. The flame of an ordinary spirit-lamp or gas-burner readily sets fire to the finely divided iron, which continues to burn brilliantly and freely. By waving the magnet to and fro, the showers of sparks sent off produce a striking and brilliant effect.

NEW METHOD FOR ASSAYING IRON.

W. N. Hartley recommends a new and beautifully simple method of assaying iron ores, in which the only apparatus needed is a balance *without weights*, and a burette. To begin with, a quantity of pure iron wire is taken (about five grammes), and balanced by a sample of the pulverized ore. The ore and wire are then separately dissolved, and each solution titrated in the usual manner by permanganate of potash. Then, to get the percentage of iron in the ore, the following simple calculation will suffice: $\frac{100m}{n} = x$. Here m and n are the quantities of permanganate solution used respectively for the ore and the wire, and x is the value sought. The method gives remarkably accurate results, even in the hands of beginners.—21 *A*, *May*, 410.

TO DETECT LEAD IN THE TIN LINING OF VESSELS.

The following simple test may be found of great service where it is desired to determine the presence of lead in vessels used for canning fruit, etc. M. Fordos directs that a carefully cleansed portion of the lining should be touched with a drop of nitric acid, whereby both metals (if present) are oxidized, the tin to stannic acid and the lead to nitrate of lead. By slowly heating the acid will be driven off, when the spot is to be touched with a drop of solution of iodide of potassium. If lead is present the spot will turn yellow by the formation of iodide of lead. The iodide has no action upon tin.—6 *B*, XII., 1875.

UTILIZATION OF THE PYRITE DEPOSITS OF THE BLUE RIDGE.

Professor T. Sterry Hunt, in a recent communication to the New York *World*, reiterates the views upon this subject which he advanced some two years ago at the Portland meeting of the American Association. He then proposed to utilize the pyrite deposits of the Blue Ridge as a source of sulphuric acid, with which to convert into fertilizers the phosphates of South Carolina on a large scale. Certain objections having been made to this proposition upon economical grounds, Professor Hunt reviews this side of the question, and places it in a very favorable light. He argues that with easily accessible beds of a high grade of pyrite or sulphur ore, like that of Spain, we might compete successfully with Sicilian sulphur, even if this were free from duty. Of this pyrite, which contains a small percentage of copper, Great Britain imports and consumes about 400,000 tons annually. The acid from this ore serves for the greater part of her soda and fertilizer manufacture; and having thus utilized the sulphur, she extracts from the residue by solution several thousand tons of copper, leaving behind a nearly pure oxide of iron, which is itself consumed in the puddling and blast furnaces. In view of these facts, Professor Hunt hopes to see a similar use made of the great deposits of pyrite, rich in sulphur and often in copper, which abound in the Blue Ridge in Virginia, North Carolina, and Tennessee. Large quantities of these ores are now being treated for the manufacture of copper at Ducktown, Tennessee, and at Ore Knob, North Carolina; and many other points in this region, in the opinion of Professor Hunt, are destined to become the seats of an important copper industry. It therefore becomes a question how those ores which are richest in sulphur may be most advantageously brought into contact with the abundant phosphates of the South Carolina seaboard. The extraction of copper as a secondary product from these ores will enable us to make acid cheaply, and to supply cheap fertilizers to the cotton-fields of the South. The fear having been expressed that these ores might contain notable quantities of arsenical compounds, Professor Hunt asserts them to be quite as free from this impurity as the Spanish ores so largely utilized in England. Upon this point, he furthermore remarks, the exceeding rarity of arsenical compounds in this region was long ago pointed out as a significant fact by Professor Henry Wurtz, of New York, in a paper "On the Cobalt and Nickel Ores of North and South Carolina," in the *American Journal of Science* for 1859; and this is confirmed by the experience of those who have been familiar with the metallurgical treatment of the pyritous ores of Ducktown and of Ore Knob, already mentioned.

NEW VIEWS OF CHEMICAL AFFINITY.

Dr. E. J. Mills has made an interesting application of principles first evolved by Esson to some observations made by Dr. Gladstone, and published in 1855 in his work entitled "Circumstances Modifying the Action of Chemical Affinity." Mr. Esson had in fact shown that when a substance undergoes chemical change, the process takes place at a rate that has a relation to the mass of the substances acting upon each other at any given moment during the process, and the relation between the time and the quantity of the chemical still unchanged at any moment may be expressed either by a complex analytical formula or by a logarithmic curve. This equation, which may be called Esson's equation, on being applied to the numerous exact observations recorded by Gladstone, leads Dr. Mills to the conclusion that 54 per cent. of the discordances between the theory and the observations are such as would on the average be found in any very good analytical work, 33 per cent. occur in ordinary good analytical works, and the remaining 13 per cent. lie on the average within the limits allowable in such estimation of colors as Dr. Gladstone made. The ordinary equations of chemistry represent the result of distributing atomic weight, and give no account of the work done. Esson's equation and conclusions worked out by Gladstone, on the contrary, represent a dynamic process as well as the distribution of weight.—7 *A*, XLVIII., 246.

WATER OF CRYSTALLIZATION.

Professor Guthrie states that the absorption of heat, which occurs when the salt is dissolved in a liquid, depends not only on the relative specific heat of the salt in the liquid, but also on the molecular ratio of the resulting solution. This ratio declares itself, first, optically by the refractive index; second, by the density; third, by the heat absorbed when a saturated solution is mixed with the medium; and, fourth, by the heat absorbed when the salt itself was dissolved in a certain quantity of the medium. The conclusion which he draws from his observations is that every salt soluble in water is capable of uniting with water in a definite ratio, forming definite solid compounds of distinct crystalline forms and constantly melting and solidifying temperatures.—12 *A*, XI., 59.

VIDAL'S APPARATUS (EBULLISCOPE) FOR THE DETERMINATION OF THE AMOUNT OF ALCOHOL IN WINE, ETC.

The following instrument, an improvement on that originally devised by Vidal, it is claimed will indicate accurately the percentage of alcohol in liquids in less than ten minutes, using but little of the liquid. It depends upon the fact that sugar, resin, citric and tartaric acids do not change the boiling point of alcohol in which they may be dissolved, and consequently the determination of the boiling point will show the amount of alcohol present in an aqueous liquid. It consists of a conical boiler, closed at the top with a screw-cap having two apertures in it, through one of which a thermometer, bent at right angles, is inserted, in such a way that the bulb can be immersed in the liquid or the vapor at pleasure, while upon the other is screwed a condenser, consisting of two concentric cylinders. At diametrically opposite points at the bottom of the boiler the ends of a small curved spiral-shaped tube are inserted. This tube, filled with the same liquid as the boiler, passes directly through the chimney of a lamp, and consequently receives upon a small surface the whole of the heat of the lamp. The fluid, thus gradually warmed, circulates through the tube and the boiler, until the whole of it has reached the boiling point, when the thermometer becomes stationary, and will remain so for ten minutes. A horizontal movable scale is fixed to the top of the boiler, by comparing which with the thermometer the amount of alcohol is indicated in degrees from 0 up to 25.—14 *C*, CCXIII., 87.

SPECIFIC HEAT OF CARBON, BORON, AND SILICON.

In 1819 Dulong and Petit discovered that when the specific heat of a solid element was multiplied by its atomic weight, the product was a constant quantity in the neighborhood of 6. Later, however, it was found that carbon, boron, and silicon were apparent exceptions to this rule. These elements have been studied in this direction by many experimenters with very discordant results; as, for instance, some found that the different modifications of carbon had the same specific heat, others that they varied widely. The subject has lately been thoroughly worked up by Dr. H. Friedrich Weber, whose results at last seem to be conclusive. Carbon he examined as diamond, graphite, coal, and charcoal, and boron and silicon in their crystalline varieties. His experiments were conducted at temperatures varying from −80° to +1000° Centigrade, and with the finest modern apparatus. With all three of the elements above named the specific heat increases very rapidly with the temperature. At 600° for carbon and boron, and at 200° for silicon, this increase almost ceases, and the specific heat remains nearly constant. Below 600° the different modifications of carbon give different results, but at and above this temperature they coincide. The constant final values, at the temperatures above named, for the specific heats of the three elements are as follows: carbon, 0.46; boron, 0.5; and silicon, 0.205. These numbers, multiplied by the atomic weights, give values in accordance with Dulong and Petit's law, so that carbon, boron, and silicon can hereafter be regarded as exceptions only at low temperatures. Dr. Weber's extremely valuable paper concludes with some speculations, based upon his results, as to the nature of carbon, which he thinks may after all prove to be not an element, but a compound.—7 *A, March and April*, 1875, 161, 276.

A HYDRATE OF CARBON.

Whether or no any true hydrate of carbon can exist has long been an open question. It is now settled affirmatively by Schutzenberger and Bourgeois. These savants treated white cast iron in coarse powder with a solution of copper sulphate, and subsequently with ferric chloride and hydrochloric acid. The metal was thus entirely removed, and a pulverulent, blackish-brown body in small quantity remained. This body was found to be a hydrate of carbon containing eleven atoms of carbon united with three molecules of water. Nitric acid attacked it energetically, changing it into a reddish-brown amorphous substance, which proved to be a new acid of somewhat complicated structure. To this acid the discoverers have given the name nitrographitoic. It also seems to be formed by the direct action of nitric acid upon cast iron.—*Bulletin de la Soc. Chimique, May* 5, 387.

CRYOHYDRATES.

Frederick Guthrie, in a paper upon "Salt Solutions and Attached Water," has described a curious new series of compounds, which he terms "cryohydrates." He finds that when any saline solution is exposed to a freezing mixture, a crop of crystals after a while separates out, containing the salt plus a definite quantity of water. Thus a saturated brine affords crystals containing one molecule of common salt united with ten molecules of water. Sulphate of zinc, under similar circumstances, forms a cryohydrate with twenty molecules of water; magnesium sulphate with twenty-four molecules, saltpetre with forty-four, sodium sulphate with one hundred and sixty-six, and so on. Similar cryohydrates are produced with alcohol or with ether in place of a salt. The most important practical feature of Mr. Guthrie's discovery, however, lies in its applicability to the production of constant, low temperatures. As is well known, water, when passing from the solid to the liquid state, remains steadily at 0° Centigrade until the change is complete. Just so each of these cryohydrates has a constant melting point which can be maintained in any mass of material until the whole is fused. The cryohydrates thus far examined command a range of temperatures from 0° to —28° Centigrade. In order to maintain a vessel at any temperature between these limits, it need merely be surrounded by the proper cryohydrate in a partially melted condition. Then, until either complete fusion or complete solidification of the cryohydrate has occurred, the temperature can not vary.—7 *A*, *January*, *March*, *and April*, 1875, 1, 206, 266.

DECOLORIZING PROPERTIES OF OZONE.

M. Boillot ascribes the bleaching effects, heretofore credited to chlorine, as being really due to ozone. Ozone, employed directly, acts as an oxidizing agent, laying hold of the hydrogen of the substance with which it is in contact, and bleaching it if the body is colored. The action of chlorine the author explains as follows: On allowing chlorine to act upon any animal or vegetable matter, it decomposes a certain quantity of water, and seizes its hydrogen, forming hydrochloric acid. The oxygen set free by this reaction is transformed into ozone, which in its turn lays hold of the hydrogen of the organic matter.—6 *B*, *May* 3, 1875.

NEW FACTS CONCERNING OZONE.

Professor Böttger has succeeded in demonstrating that not only during the decomposition of water, but also on its formation by the union of oxygen and hydrogen, appreciable quantities of ozone are generated. In this connection we recall the fact announced several years ago by Dr. Pincus that ozone is formed during the burning of hydrogen, and that if a jet of this gas issuing from a fine point is ignited, the smell of ozone can be distinctly recognized. In close connection with both of these observations, however, is the discovery previously made by Mr. Loew, and since patented by him, that ozone may be obtained in sufficient quantity for lecture-room demonstration and other purposes by simply blowing the heated air in contact with the margin of an ordinary Bunsen gas flame, with the aid of a glass tube, into a suitable receiver. If the product thus obtained is then tested with one of the ordinary reagents used for detecting ozone—viz., iodide of potassium, acetic acid, and starch—the blue coloration of the iodide of starch at once appears. At the time Loew's announcement met with some objectors, who sought to explain the phenomenon by assuming that the subsequent reaction was to be ascribed to the formation of small quantities of partly oxidized nitrogen products formed during combustion. The subsequent discoveries of Pincus and Böttger, however, appear to have settled the question by confirming the conclusion of Loew.

CARBONIC OXIDE IN TOBACCO SMOKE.

Dr. Krause has found that tobacco smoke contains a large quantity of carbonic oxide, and he attributes the injurious after-effects of smoking to this poisonous gas, some of which necessarily descends to the lungs, and produces more or less injury. According to Krause, the after-effects are more potent the more inexperienced the smoker, and he ascribes to the carbonic oxide the unpleasant results of the first attempts at smoking rather than to nicotine alone.—12 *A*, *April* 6, 1875, 456.

MELLILOTOL.

Dr. T. L. Phipson publishes an account of what he calls mellilotol, as being an acid oil slightly soluble in water, soluble in alcohol and ether, and transformed into mellilotic acid by the action of potassa. It is endowed with most fragrant odor—that of new-mown hay. He obtained it by the distillation of *Mellilotus officinalis* with water, and isolating from the distillate by means of ether. The plants may be gathered while in full bloom, those growing in sheltered places and flowering in August being richer in product. About 0.02 per cent. of pure mellilotol was obtained from the dried plant by distilling the stalks, leaves, and flowers together.

Mellilotol, according to Dr. Phipson, is the starting-point of a great variety of very interesting compounds, and it yields, as before stated, mellilotic acid, which in its turn yields coumarin. It is mellilotol, and not coumarin, which is the cause of the odor of new-mown hay and of that of the flowers of the *Mellilotus.*—1 *A*, *July* 16, 25.

MANUFACTURE OF ARTIFICIAL VANILLA.

It is not long since Messrs. Tiemann and Haarmann, students of Dr. Hofmann, of Berlin, made the discovery that vanillin, or the aromatic principle of the vanilla bean, can be obtained from the sap of the pine. These gentlemen have now completed their operations for going into the manufacture of the article on a large scale, as they find that the sap of an ordinary tree will furnish vanillin of the value of $20, without in the least injuring the wood for timber. Dr. Hofmann, in communicating these facts to the Academy of Sciences of Paris, remarks that this is the second vegetable product manufactured by purely chemical methods.—12 *A*, *September* 24, 1874, 427.

HYDROGENIZED IRON.

Cailletet states that in his experiments on the passage, at ordinary temperatures, of hydrogen through iron, he has found that on allowing sulphuric acid to act upon a plate of iron, the hydrogen is, in part, absorbed by the metal, and that, by employing a system formed of two plates of iron soldered side to side, he finds the tension of the gas which accumulates in the apparatus is equal to a column of mercury 0.35 millimeter high. As the result of his investigations into this combination of iron and hydrogen, he says that this iron gives up, under water or other liquid, numerous bubbles of a gas which is pure hydrogen. In the open air the galvanic iron loses only a part of the hydrogen which it has occluded. When a piece of hydrogenized iron is brought near a burning body the hydrogen is rapidly disengaged, and the metal is surrounded by a light-blue flame. When the iron has lost by heat the hydrogen which it contained, one can not restore that gas to it. Employing a piece of iron that had been so heated as a negative electrode, Professor Cailletet found that the water is decomposed and the hydrogen disengaged as usual in abundance;

but the hydrogen does not again become occluded in the iron plate. Hydrogenized iron can be easily pulverized, but after it has been heated it retains a certain ductility. Hydrogen, in associating itself with the iron, communicates to it considerable magnetic force, so that the presence of hydrogen in iron modifies greatly the magnetic properties of this metal.

MICROSCOPIC EXAMINATIONS OF THE PROCESS OF CRYSTALLIZATION.

Professor Frazer, Jr., exhibited to the Academy of Natural Sciences of Philadelphia a combination of the polarizer, vertical lantern, and microscope, by means of which the manner in which different salts crystallize out of their solutions, together with the manner in which they affect polarized light, can be explained and illustrated. The light from a lime lantern is passed through a rubber tube polarizer, then upward through the vertical lantern and a two-inch lens microscope, when it is again reflected horizontally on the screen. He explains that while this method has the advantage of so magnifying the crystals produced from small quantities of solutions that their structure can be minutely observed, as well as the sudden molecular change which causes the polarizing effect, it is open to the objection of a very large loss of light, first by the polarizer, and again by the microscope. A part of this difficulty, however, can be obviated by the use of the parabolic reflector.—*Proc. Acad. Nat. Sci., Phil.*, 1875, 16.

A BRITTLE ALLOY OF IRON AND HYDROGEN.

Mr. Johnson communicates to *Nature* some important observations in reference to the action of hydrogen on iron and steel. Experiments made by him have shown that any acid which gives off hydrogen, when it is allowed to act upon iron or steel, produces the same effect, viz., of depriving the metal of its original toughness, and gives it the property of frothing when moistened with saliva. The gas coming off the surface of the iron, if cold, is shown to be hydrogen; and it seems probable that the brittleness of the metal is due to the occlusion of hydrogen within the iron. The simplest way of charging a piece of iron with hydrogen is by laying it on a sheet of zinc in a basin of diluted sulphuric acid. The hydrogen generated by the action of the acid on the zinc is given off on the surface of the iron; and two minutes or less will suffice to charge a piece of iron with hydrogen, and alter its properties completely. This alteration is not confined to a diminution of toughness, which may be reduced to one quarter of its original value, but is also accompanied by a marked decrease in tensile strength, amounting in cast steel to upward of twenty per cent.; but in the case of iron-ware to only six per cent. The electrical resistance is increased by this occlusion of hydrogen. It is probable that repeatedly rusting iron occludes hydrogen, and it is thereby deteriorated in strength and toughness.—*Nature*, II., 903.

THE COMPOSITION OF BLEACHING-POWDER.

The question of the composition of the so-called "chloride of lime" has lately been much agitated. The generally received view of Gay Lussac, that it is a true calcium hypochlorite, has been attacked by Goepner, who regards it as merely a molecular compound of lime and chlorine, containing no hypochlorous acid. Mr. Ferdinand Kopfer now submits the subject to the test of a long series of careful experiments, and decides in favor of the old view. He finds that when a dilute mineral acid, just sufficient to saturate the calcium present, is added to a solution of bleaching-powder, no smell of free chlorine can be detected, but only the characteristic odor of hypochlorous acid. The solution thus obtained, shaken up with a large excess of mercury, yields the brown oxychloride of the metal, again proving the presence of hypochlorous acid.—*Jour. Chem. Soc.*, *August*, 1875.

THE INCOMPLETE COMBUSTION OF GASES.

The habilitation thesis of Dr. Ernst Meyer on the incomplete combustion of gases contains the following suggestive sentences: The studies upon inflammability, which, according to the experiments contained in this essay, stand in a closer connection with the phenomena of affinity than we should at first suspect, indicate the importance that must be attributed to the thermal relations of the gases. The combustion of carburetted hydrogen in a closed tube, which, beginning with the overleaping of the limits of inflammability, and with increasing quantities of oxygen, exhibits a series of different steps, until finally, by its total combustion, we reach an invariable final result, exhibits many interesting passages. Simple as is the result of the complete combustion, the incomplete combustion is exceedingly complex. If a mixture of carburetted hydrogen with oxygen approaches the limit of inflammability, then, in general, the steps of the combustion are exceedingly complicated. In this case the strong affinity of carbon for oxygen is shown, in that the latter at first serves exclusively to form carbonic oxide. When the hydrogen begins to take part in the burning, then there becomes evident, as we recognize from the compound nature of the resulting mixture of gases, an effort to establish an equilibrium according to the properties of the molecules. Similarly, under simpler conditions, in the case of the incomplete combustion of a mixture of carbonic oxide and hydrogen, the burning gases arrange themselves according to their molecules; and the same regularity holds in the complicated processes of the combustion of carburetted hydrogen, while in the latter the play of the affinities of carbon and hydrogen in general is easily recognized. Although we can not obtain clear views concerning their relative proportions, still the observations which are here given form definite starting-points for further considerations. These simplest processes will, perhaps, assist in the solution of problems of the highest importance in the mechanical explanation of the phenomena of chemical affinity. Precisely those conditions which variously affect the affinity of hydrogen and carbonic oxide, and which, as we may assume, may be referred to the different friction of the gases, point to causes which must be sought in the moving molecules themselves. A thorough study of such modifying circumstances will certainly advance our knowledge of the nature of chemical affinities.—*Habilitations Schrift, Leipzig*, 1874.

GASES OCCLUDED IN METEORITES.

The meteorite that fell on the 12th of February, 1875, in Iowa, has been examined chemically by Professor Wright, of New Haven, who has shown that in the gases contained within it there was a great predominance of the carbon compounds, which were plainly indicated by spectroscopic analysis; and by careful quantitative analysis it was found that 49 per cent. of the occluded gases were carbonic acid and carbonic oxide; the residue consisted largely of hydrogen. This meteorite is of the stony kind, in which the oxides of carbon are the characteristic constituents, while in the iron meteorites hydrogen is most abundant. The spectrum of the gases evolved from this meteorite, at a few millimeters' pressure, gave brilliant carbon bands; the brightest were the three in the green and blue, the red only being much feebler; agreeing in this respect remarkably with the spectrum of some of the comets, and affording a decided confirmation of the received theory as to the meteoric character of those bodies.—4 *D*, III., x., 44, *July*, 1875.

SOURCE OF THE ACID OF THE GASTRIC JUICE.

The theories which have been proposed to account for the acidity of the gastric juice agree that this acidity is due to hydrochloric acid; but they differ as to the mode of its production. One theory supposes that the chlorides of the food are decomposed by the lactic acid which results from the decomposition of the carbohydrates ingested; the other that these chlorides are decomposed by simple dissociation. To test these theories, Maly has made a series of experiments, mainly upon dogs, but also upon the human subject. He confirms Bence Jones's observation that the acidity of the urine is diminished during the secretion of the gastric juice, being a minimum when the digestive process reaches its maximum activity. But as this fact may be accounted for on either theory—according to the first the lactates produced being oxidized to carbonates, and so entering the urine, and, according to the second, the dissociated alkali entering the urine directly—Maly sought to decide the question by ascertaining whether chlorides could be decomposed by lactic acid. Sodium chloride and lactic acid, when distilled, gave only at the last traces of hydrochloric acid. But diffusion experiments, in which lactic acid was mixed with sodium, calcium, magnesium, and ferrous chlorides, showed that hydrochloric acid was formed in dilute solutions. The question then recurred on the formation of lactic acid in the living stomach.

Fragments of the mucous membrane of the stomach of the pig were digested at 40° Centigrade with two per cent. solutions of grape sugar, cane sugar, milk sugar, and dextrin. Lactic acid was formed, but the process was stopped at 100° Centigrade. Gastric juice, however, used in place of the membrane, produced no such effect. From the fact that an abundance of bacteria were developed at the same time, Maly considered it quite clear that the formation of lactic acid results from an organized and not from a chemical ferment; and therefore that the production of lactic acid is not a function of a living membrane. This view is strengthened by the fact that the fresh stomach of a dog, when digested with a two per cent. solution of grape sugar, gave no acid until after two days. Moreover, the stomach of a living dog was emptied, milk of magnesia introduced, withdrawn after an hour, and the magnesia dissolved determined; then the sugar solution was introduced with the magnesia, and the experiment repeated. The same amount of dissolved magnesia was found in both cases, showing that the living membrane does not cause the formation of lactic acid from sugar. The author maintains, therefore, that free lactic acid is absent from gastric juice, and that hence, *à fortiori*, it does not decompose chlorides to set free hydrochloric acid. The source of this latter acid in the gastric juice the author believes to be dissociation.—33 *C*, CLXXIII., 227.

DECOMPOSITION OF CHLORAL HYDRATE IN THE SYSTEM.

It was assumed by Liebreich, the discoverer of the peculiar physiological action of chloral hydrate, that this substance, under the influence of the alkaline blood-serum, was decomposed, yielding chloroform. Tanret has shown, however, that if a solution of chloral hydrate be mixed with an alkaline solution of potassium permanganate, the liquid is decolorized, a gas is evolved, and manganic oxide is precipitated. If the quantity employed be considerable, and the temperature be kept from rising above 40° Centigrade, the reaction is slow, and the filtered liquid will be found to contain chloride, carbonate, and formate of potassium. The gas evolved is carbonous oxide. The same reaction can be effected in very dilute solutions, and takes place even when the alkalinity is produced by borax. From these data the author proposes a new theory to account for the action of chloral hydrate in the animal economy. When taken into the body, it is not only submitted to the alkaline serum, but to oxidizing agencies at the same time. Both these causes taken together effect its decomposition in the manner above described, carbonous oxide being set free in the blood, displacing its oxygen and producing symptoms analogous to those observed in cases of poisoning by this oxide of carbon. Moreover, the lowering of the temperature of the body, which is observed in these cases, and the prolonged action observed with chloral hydrate, combine to render this hypothesis more tenable than the old one. Fatal poisoning by chloral hydrate is not at all an impossible thing, therefore, if these facts be true.—6 *B*, LXXIX., 662.

GALLIUM, A SUPPOSED NEW CHEMICAL ELEMENT.

Lecoq de Boisbaudran announced to the French Academy, on the 27th of August, that he had discovered a new chemical element in a blende from the Pierrefitte Mine, valley of Argèles, Pyrenees. Its chemical reactions resemble those of zinc, but it differs from this metal in being precipitated as oxide by zinc, and also by the following facts: That its chloride is precipitated by ammonia; that its oxide is soluble in an excess of ammonia; that its sulphide is precipitated by ammonium sulphhydrate, and is insoluble in excess of the precipitant; that this sulphide is thrown down in presence of acetic though not of hydrochloric acid; that barium carbonate precipitates it even in the cold; that the chloride is not volatile; and that when the solution containing zinc is heated up to the point of production of oxychloride, all of the new substance remains insoluble. In a subsequent paper presented to the Academy a month later, the author proposes the name *Gallium* for the new metal, and gives more complete statements of its spectroscopic characters. In concentrated solution, it gives with the electric spark a spectrum containing two prominent lines. One of these is a moderately bright violet line of wave-length 417. The other is fainter, and has a wave-length of 404. The chloride gives the line 417 in the ordinary gas flame.—6 *B*, LXXXI., 493, *Sept.*, 1875.

CONSTITUTION OF AMMONIUM AND ITS DERIVATIVES.

Valuable to the science of chemistry as the theory of equivalence has been, it has yet very much to do before it can be admitted to be complete. Indeed, the signs of the times point to a period not very distant when it will be merged into some higher and broader generalization. Chemists are not now agreed, for example, upon a point which would seem to lie at the very foundation of such a theory: namely, whether the equivalence of an element is a fixed quantity for that element, or whether it can vary. In the case of nitrogen, for example, all are agreed that it may and does act as a triad in ammonia; but in ammonium chloride, NH_4Cl, where it is combined with five monad atoms, all are not willing to concede that it is quinquivalent. Meyer and Lecco have sought to throw some light upon this question by a careful study of the compound ammoniums. If two of the four atoms of hydrogen in ammonium chloride be replaced by ethyl and two by methyl, two isomeric bodies can be formed if the nitrogen be a triad—thus $N(CH_3)_2C_2H_5+C_2H_5Cl$ and $N(C_2H_5)_2CH_3+CH_3Cl$; while, if it be a pentad, these bodies, prepared even though they be in different ways, must be identical. The former of the two was prepared from dimethylamine, and the latter from diethylamine; and the compounds themselves as well as their derivatives were subjected to the most careful scrutiny, but not the smallest difference could be observed between them. A critic having suggested that possibly a rearrangement of atoms within the molecule having taken place caused this similarity, the authors specially tested the matter, but with a negative result. They maintain, therefore, that the equivalence of nitrogen in ammonium is five, and that equivalence is variable.—35 *C*, VIII., 233, *March*, 1875.

WHY DOES PLASTER OF PARIS SET?

Landrin has examined the chemical and physical changes which are produced in the setting of plaster of Paris. He notices that three separate actions take place, and that these may very readily be observed under the microscope. They are: First, the burned plaster in contact with the water assumes a crystalline form. Second, the water which envelops the crystals takes up in solution considerable calcium sulphate. Third, a portion of this water being evaporated by the heat resulting from the chemical combination, a crystal is formed which determines the crystallization of the whole mass, just as when a crystal of sodium sulphate is dropped into a supersaturated solution of that salt. It is not, however, until after some time that the mass acquires its maximum hardness, the plaster then containing the required proportion of water, *i. e.*, two molecules to one of the calcium sulphate. This amount of water does not lessen by evaporation. In mixing plaster, only about 12 per cent. of water should be added, as ordinary plaster itself contains about 8 per cent.; but in actual practice the amount used is never less than 33 per cent. This excess is added in order to prevent setting of the mass before it can be used. But the effect is injurious, since very porous, slowly drying plasters are produced in this way, which rapidly determine nitrification. To diminish the rapidity of setting is to delay the crystallization, which can be effected by adding gum, gelatin, guimauve powder, glycerine, and similar bodies. Inert substances, like sand and barium sulphate, for example, on the other hand, simply diminish the solubility of the material, without in the least retarding the setting process. Overburned plasters may be utilized by admixture with ordinary plaster, since the crystallization of the latter extends to the former, and occasions the setting of the entire mass. A similar effect is produced by simply mixing the two plasters together. Lime acts favorably upon plaster, as it not only increases the rapidity with which it sets, but it gives it an additional hardness. Plasters to which 10 per cent. of lime has been added are capable of taking a polish. Samples have been made containing as high as 75 per cent. of lime; they are hard and light, and may yet serve some useful purpose in the arts.—6 *B*, LXXIX., 658.

CONSTITUTION OF GUM TRAGACANTH.

Giraud has made a minute examination of the chemical characters of gum tragacanth. He finds (1) that this gum is but very slightly soluble in water, and that the product in the filtrate is not a definite principle like arabin, but is a mixture of several substances; (2) that digested on the water-bath for twenty-four hours, with fifty times its weight of water, much of it is transformed into a soluble gum, which no longer swells after drying: this new substance is pectin; (3) that under the action of water containing one per cent. of acid, the production of pectin takes place in two or three hours. It becomes entirely soluble, and alcohol precipitates pectin, not arabin, from the solution. Alkalies change it into pectates and meta-pectates. Hence gum tragacanth consists for the most part of a pectic principle insoluble in water, apparently identical with Fremy's pectose. From it by precipitating the pectin solution by barium hydrate and decomposing by an acid, pure pectic acid was obtained. Upon analysis, gum tragacanth yields as follows: Water, 20 per cent.; pectic compounds, 60 per cent.; soluble gum, 8 to 10 per cent.; cellulose, 3 per cent.; starch, 2 to 3 per cent.; mineral matter, 3 per cent.; nitrogenous matters, traces.—4 *B*, III., v., 361, *April*, 1875.

CARBONYLES, A NEW CLASS OF ORGANIC BODIES.

Berthelot has recently instituted a new class of organic bodies, to which he has given the name *Carbonyles*, and to which he assigns three bodies hitherto rather ambiguous in their chemical behavior. These are allylene oxide, diphenylene acetone, and ordinary camphor, to which he gives the new names dimethylene carbonyle, diphenylene carbonyle, and terebutylene carbonyle. The distinguishing feature of carbonyles is their double function. In the first place they act like aldehydes, being able to fix hydrogen directly and to produce alcohols; while they are themselves reproduced, like aldehydes, by hydrogenization of these alcohols. Again, like aldehydes, they may be formed by the direct or indirect oxidation of hydrocarbons; camphene hydride and oxygen producing camphor precisely as ethylene hydride and oxygen produces common aldehyde. But, secondly, it is to be observed that while aldehydes are produced by the indirect oxidation of saturated hydrocarbons, carbonyles result from the indirect oxidation of unsaturated hydrocarbons. This is a very material difference, since, besides its aldehydic function, the carbonyle molecule is itself unsaturated for this very reason, and hence can combine directly with other saturated molecules. Like the radical carbonyl itself, from which these bodies take their name, they can therefore fix directly the elements of water and form monobasic acids; dimethylene carbonyle uniting with water directly and yielding propionic acid. Moreover, by virtue of this unsaturation they can unite directly with three atoms of oxygen to form dibasic acids; camphor yielding camphoric acid in this way. Conversely, the removal of water and carbonic dioxide from a single molecule of a dibasic acid yields a carbonyle; thus differing from the analogous production of ketones, by the fact that in the latter case the removal is from two molecules of a monobasic acid. The author gives evidence to show that camphor belongs to this class of bodies, and says that, had he not hesitated to found a new class of bodies on a single compound, he would have proposed camphor as a carbonyle long ago.—*Bulletin de la Société Chimique de Paris*, II., xxiii., 146, *February*, 1875.

HÆMATIN NOT FERRUGINOUS.

It has been for some time known that the proportion of iron which existed in the coloring matter of the blood, called hæmatin, was very variable, and that by repeated purification it could be so far reduced in amount that only a trace remained. Hence the opinion has arisen that the iron is not an essential constituent, as is generally supposed. Paquelin and Jolly have examined the question at length, starting from the well-known researches of Chevreul upon this substance, which were to the same purport. The results have shown the correctness of the assumption, they having succeeded in devising a process by which the whole of the iron may be removed and the hæmatin obtained pure. In brief their method is as follows: Having removed the albuminates of the blood by basic lead acetate, the corpuscles are dried and powdered, then digested in glacial acetic acid until they are reduced to a gelatinous mass. The coloring matter is then taken up by carbon disulphide or benzene, and the hæmatin recovered by careful evaporation of the solvent. The corpuscles may with advantage be macerated in alcohol containing ten per cent. of ammonia previous to the treatment with acetic acid. The purification of the hæmatin from the iron is the next step. It is dissolved in ten times its weight of acetic acid, two and a half parts of citric acid dissolved in a little water is added, and the whole is brought to boiling to favor the solution of the iron. To the cooled liquid, ammonia is added in quantity sufficient to exactly neutralize the acids, and the precipitated hæmatin allowed to subside. This treatment is repeated so long as ammonium sulphide discovers in the supernatant ammoniacal liquid any trace of iron. The purified hæmatin is finally dissolved in ether, the solution filtered, and the ethereal liquid allowed to evaporate spontaneously. The pure coloring matter is insoluble in water, slightly soluble in alcohol, but readily so in ether, chloroform, carbon disulphide, and benzene. It burns on platinum like a resinous substance, without leaving any trace of ash.—6 *B*, LXXIX., 918.

FORMATION OF SULPHATES BY GAS FLAMES.

A white incrustation is always formed after a short time on the glass covers hung over gas flames. This incrustation consists of small crystals of normal ammonium sulphate, with a trace of soda and potash. The sulphur in the gas which is burned to produce the sulphuric acid does not exist in the condition of hydrogen sulphide, but in that of carbon disulphide. The ammonia is not a product of combustion, for if a basin whose lower surface is moistened with hydrochloric acid be held over a gas flame, there are no fumes visible, and no ammonia is found even with the delicate reagent of Nessler. But unburned gas contains a small quantity of ammonia, enough to give a yellow color with the Nessler test. Priwoznick has investigated this question, and supposes that the ammonia comes from the nitrogen of the air, for Saussure has shown that ammonia is formed when hydrogen is burned in oxygen containing nitrogen. Schönbein proved the presence of ammonium nitrate in the products of combustion of fat and of coal-gas. The carbon disulphide in the gas would burn to carbonic and sulphurous dioxides. But sulphurous oxide can not exist in presence of ammonium nitrite, but is immediately oxidized to sulphuric acid and combines with the ammonia. The glass cylinder of an argand lamp is also often covered with a white incrustation. This consists mainly of potash, soda, lime, etc., from the ash of particles of dust in the air.—14 *C*, CCXIII., 223.

ON A NEW COLORING MATTER CALLED EOSIN.

In 1871 Baeyer observed that when pyrogallol was heated with phthalic oxide under such circumstances that water was abstracted, a peculiar body resulted, which was brown-red in color with a yellowish-green lustre, and which dissolved in alkalies with a magnificent blue color. To this substance he gave the name Gallein. A short time afterward he observed that this reaction was entirely general, and that whenever a phenol of any atomicity was heated in this way in presence of a dibasic organic acid, a coloring matter was the result. The body thus obtained gave rise to two derivatives; one of which is its anhydride, and the other its reduction product. For the coloring matter itself Baeyer proposes the termination *ein;* and for its reduction product, which is colorless, *in.* Thus with phthalic acid and phenol, for example, there is a phthalin and a phthalein of phenol. Among the various phenols which were thus treated with phthalic oxide was resorcin, one of the three diatomic phenols. Of course the products were a phthalin and a phthalein of resorcin. The phthalein of resorcin was obtained in yellow flocks which dissolved in ammonia, giving a red solution, which had such a magnificent green fluorescence as to secure for it the separate name fluorescein. It would seem as if a coloring matter like this, prepared from substances exceedingly rare, and obtained only in minute quantities by long and tedious chemical processes, could never become an article of commerce. But early in the present year Hofmann had placed in his hand a new coloring matter, which had only a few months before come into practical use. This new coloring substance had the name Eosin, a name given in allusion to the beautiful red color of its aqueous solutions, recalling that of the morning dawn. Upon investigation, eosin turned out to be a derivative of the remarkable coloring matter which Baeyer had called fluorescin. It was the potassium salt of tetrabrominated fluorescin, or, what is the same thing, of the phthalein of dibrom-resorcin. It is prepared commercially at the Baden Aniline Works, by Caro. Baeyer proposes the following test for it: A portion of the coloring matter is agitated with water and sodium amalgam at a gentle heat. The solution is soon decolorized, the bromine being removed and colorless fluorescin produced. If now water be added and a few drops of potassium permanganate solution, the fluorescin changes to fluorescein, and the liquid becomes quite green and almost opaque in reflected light.—35 *C*, VIII., *January*, 1875.

PEROXIDE OF HYDROGEN IN THE ATMOSPHERE.

Schöne has made a series of experiments in the vicinity of Moscow to determine the amount of hydrogen peroxide in the atmosphere. Between the 1st of July and the 1st of December, 1874, he examined for this purpose one hundred and thirty specimens of rain and twenty-nine specimens of snow. Of the whole number of specimens of rain, only four failed to respond to the test, though out of the twenty-nine specimens of snow twelve gave no reaction. Having established the fact, the author continued his investigations with reference to the following points: (1) Form of occurrence of hydrogen peroxide in the atmosphere—whether gaseous or dissolved in the fluid or solid rain or hail; (2) relation to other meteoric phenomena, to time of day, and to season of the year; (3) relation to the ozone of the atmosphere; (4) how produced in the air; (5) part played by it geologically and botanically; (6) action upon the animal economy when breathed; and (7) hygienic importance. For this purpose, all the rain, hail, snow, dew, and frost were collected and tested for hydrogen peroxide, the analyses being quantitative when possible. Further, at various times, especially in clear weather, artificial dew and frost were prepared and examined. Careful meteorological records were kept during the entire interval at the adjoining observatory. The ozone was determined with a Schönbein's ozonometer. The results show that the quantity of hydrogen peroxide in rain varies from 0.04 to 1 milligramme per liter; that the larger the drops the greater the amount; that the first rain after dry weather is poorer in peroxide than that which falls later; that the peroxide is greatest when the wind is south and southwest, that in the rain brought by the equatorial current being greater than that which falls in the rain produced by the conflict of this with the polar current, or brought by the latter current itself; that the relative quantity of peroxide in rain increases from the summer solstice to the autumnal equinox, and then diminishes; that the quantity is not greater in rain which falls during a thunder shower; and that during the four months the absolute quantity of hydrogen peroxide contained in the 221 liters of rain which fell upon each square meter was only 62.9 milligrammes. In snow there was only 0.05 milligramme of peroxide to the liter, the amount diminishing toward the winter solstice. Natural dew and frost contain no peroxide, or at least less than one twenty-five millionth of this substance. In artificial dew and frost the amount of peroxide varied from 0.04 to 0.06 milligramme per liter, reaching on a bright moonlight night in summer 0.09 milligramme. The amount increased with the altitude of the sun. The daily maximum was reached between 12 and 4 o'clock P.M., and the annual maximum in the month of August. The amount is greater the higher the temperature, the clearer the sky, the higher the absolute and the lower the relative humidity of the air. The author concludes that the peroxide is contained in the air both free and in solution, to the extent as a maximum of 0.000000268 c. c. in a liter. He also believes that sunlight plays an important part in its production.—35 *C*, VII., 1693.

TARTRONIC ACID A GLYCERINE OXIDATION PRODUCT.

Hitherto tartronic acid has only been known as a product of the spontaneous decomposition of nitro-tartaric acid and as a reduction product of mesoxalic acid. Theoretical considerations led Professor Sadtler, of the University of Pennsylvania, to conceive that this acid might be formed by the oxidation of glycerine, and hence to search for its presence in the products of this reaction. For this purpose one part of glycerine was mixed with an equal weight of water, and to this was added about one and a quarter parts of fuming nitric acid. This latter was poured into the vessel through a long funnel tube, so as to form a layer upon the bottom. After about six days the evolution of gas had ceased, and the solution was evaporated at a gentle heat to a sirupy consistence, then diluted, and lead carbonate added in excess. The liquid filtered from the mixed lead oxalate and carbonate gave, upon evaporation, thick crusts of lead glycerate. These, redissolved in water, were freed from lead by hydrogen sulphide, the solution concentrated, neutralized by calcium carbonate, filtered, and treated with an equal volume of alcohol. After twelve hours the greater part of the calcium salt had completely separated. At first the author supposed this to be calcium glycerate in a pure form; but by solution in warm water it left a residue, which only dissolved by long boiling. This residue, about a tenth part of the entire salt in amount, was filtered off, washed, and dried. It appeared as a white powder, non-crystalline. Upon analysis this powder gave numbers agreeing very closely with calcium tartronate. Conversion into the acid confirmed this supposition. Under the glass the acid crystallized in tables having the form of the tartronic acid from nitro-tartaric acid. This view was confirmed by the results of its elementary analysis.—35 *C*, VIII., 1456, *Nov.*, 1875.

ACTION OF WEAK ACIDS ON SALTS OF STRONGER ONES.

The importance in chemical dynamics of the question, What is the condition in which several substances exist when in solution? has been oftener recognized than experimentally investigated. Bergmann advanced long ago the theory that is now generally maintained, *i. e.*, that universally bodies combined according to the strength of their chemism. Berthollet, on the other hand, asserted that when different salts were dissolved together, as many bodies were formed as by the exchange of acids and bases were possible. Among the experiments made to settle the question, those of Bettendorff are perhaps the most satisfactory. By studying the action of light on certain solutions, he was led to decide for the view of Bergmann. Hübner and Wiesinger, not regarding these experiments of Bettendorff as sufficiently numerous or comprehensive, have made use of a different method for solving the problem by making the distinct proposition: Can a dissolved acid expel a stronger one from its salts in solution without any substance separating from the solution? For these experiments they used benzoic acid for the weaker and nitrobenzoic acid for the stronger acid. They are both monobasic, are easily obtained pure, are easily separated from each other and from their salts, and can be recognized with certainty. They differ only apparently in the strength of their chemism. In the qualitative experiments, barium nitrobenzoate and free benzoic acid were dissolved in a large excess of water, the solution being heated to 80° Centigrade. After cooling to 14°–17°, the solution contained not only the substances originally dissolved, but also free nitrobenzoic acid and barium benzoate. The nitrobenzoic acid set free in the reaction, together with the benzoic acid also present, was dissolved by agitation with chloroform or benzene, in which the barium salt is insoluble. In the residue, after the solvent was distilled off, the presence of nitrobenzoic acid was proved by means of sodium. In a quantitative experiment, 1.6592 grammes of pure barium nitrobenzoate was mixed with the theoretical quantity 1.1815 grammes of pure benzoic acid, and dissolved in an excess of hot water. The nitrobenzoic acid obtained from the solution was 0.2341 grammes, being 19.81 per cent. of the whole quantity. Additional experiments seem to show that the quantity of the stronger acid set free depends on that of the weaker.—35 *C*, VIII., 466, *April*, 1875.

COPPER IN THE HUMAN BODY.

Not long since, in a case of suspected poisoning by a salt of copper, upon analysis a large percentage of metallic copper was found in the liver and kidneys. Subsequent research, however, proved that copper usually exists as a normal constituent of the animal body, the investigation having taken place upon fourteen human subjects from the French hospitals. Portions of these were first dried, then carbonized, and the ashes treated for copper, the amount of which varied in quantity from $\frac{7}{10}$ to 1½ milligrammes. The same metal has even been found in the liver of the human fœtus.—13 *B*, *Feb.* 20, 1875, 186.

RELATIVE AMOUNTS OF POTASH AND SODA IN MILK AND OTHER FOOD, AND IN THE ENTIRE BODY.

In pursuing the investigation of the value of salt in nutrition, Bunge was led to determine the amount of the alkalies and of chlorine in the most important articles of food, especially in milk; and, in this connection, the amounts of the alkalies and of chlorine in the entire bodies of a number of animals was also ascertained. Besides analyses of human milk, and of that of herbivorous and carnivorous animals, analyses were also made of the entire bodies of a mouse, four cats, two young dogs, two young rabbits, five rabbit embryos, and of a number of butterfly chrysalides, and the amount of soda and of potash in different articles of food was found. From the numbers thus obtained, and given in tabular form, interesting conclusions were drawn, in regard to the relation existing between the food and the composition of the body, as regards the amount of the alkalies and chlorine present. In vegetable food the excess of potash over soda, compared by equivalents, is much greater than in human milk, or those in that of herbivorous animals; so that, if the proportions of potash and soda in milk are to be considered as the most favorable to nutrition, the addition of salt to all the more important vegetable articles of food is indicated. The amount of soda in the organism varies within as wide limits in the animal kingdom as in the vegetable, and the amount of soda, potash, and chlorine in milk is not constant, but varies with the food and other conditions. The young of the carnivorous animals receive in their milk potash and soda, and generally all the fixed ingredients, in almost the same proportions required for their growth; and while in the bodies of the young of herbivorous animals the relative amounts of soda and potash are found to differ from those of the carnivorous animals, the relative amounts of these substances secreted in the milk by which they are nourished conform to this difference. Prolonged feeding, however, upon substances rich in potash and poor in soda will increase the relative amount of the former in the milk.—19 *C*, *Jan.* 23, 1875, 35.

E. MINERALOGY AND GEOLOGY.

POT-HOLES, OR "GIANT KETTLES."

It is not always that geological investigations have as their object phenomena which are of general interest, and with which all are more or less familiar. This is certainly the case, however, with the study of the "giant kettles" in the neighborhood of Christiania, Norway, which has been lately carried on by Professor Kjerulf and some of his students. There is hardly a running stream in our country of any considerable size which does not give proof of the power of water and stones in motion in what are popularly called "pot-holes." An eddy in the stream where the current is strong sets a few pebbles in revolution. These commence a depression, into which larger stones fall, and the grinding is continued until a cavity has been produced perhaps several feet in depth, and almost perfectly round. These are often to be observed, not only in stream beds, but also in rocks on the sea-shore, where the rush of the tide must supply the motive force.

The famous "giant kettles" of Norway are simply "pot-holes" on a larger scale, and produced in former times under somewhat different conditions than we have at present. The superstition of the people represents them as having been made by giants. In some places, where the form is oblong and irregular, fancy has seen in them the footprints of these monsters, while in one place, where the road goes directly through a very large kettle, the saying is that there St. Olaf turned his horse around. On the west coast of Norway another name is used, and they are spoken of as giants' chairs.

The description of one of these kettles examined by Professor Kjerulf will give some idea as to their size and general character. At the surface it had a diameter of about eight feet, being slightly elliptical in form. It widened considerably on the descent, and then contracted again at the bottom. It is interesting to note that the walls were distinctly worked out in a spiral, which could be traced from top to bottom. In the case of some other kettles examined, the spiral was so perfect that the cavity could be compared to the impression of a gigantic snail.

The total depth of the kettle in question from the highest point of the margin was forty-four feet, the axis inclining somewhat toward the west. It was filled, as is always the case, with gravel and broken rock, though toward the bottom numerous so-called grinding-stones were found, some of them 300 pounds in weight, and all smooth and elliptical in shape. It was through their revolution that the excavation had been made. It required three men, working for fifty days, to clear this giant kettle of its contents, and the whole amount taken out was estimated at 2350 cubic feet, some of the stones being so large that they had to be mined before they could be hoisted out.

The kettles, in general, present much the same features as the one which has been just described, though there is a great variation in ratio of width to depth, many of them being shallow, larger at the top than at the bottom, and very properly are called kettles, while others, as the one alluded to, are deep, and could better be called wells. It is to be observed that they are by no means necessarily found in present river channels. They are most common in the neighborhood of the great fiords, though they have been observed too at a height of 1200 feet above the sea. In regard to their origin, the best authorities refer it to the time when the land was covered by enormous glaciers, such as now exist in the upper part of Greenland. The melting of the ice on the surface of glaciers gives rise to considerable rivers, and as these find some crevice in the ice, they descend with violence, and it is conceivable that such a stream striking the bed rock below might be the means, with the masses of rock they would put in motion, of producing the enormous cavities which are now observed. This theory, as carried out by its supporters, meets with some difficulties, but seems to be the best which has been proposed.

PROBABLE AGE OF THE CRYSTALLINE ROCKS OF THE SOUTHERN APPALACHIANS.

Professor Bradley, of Knoxville, Tennessee, has recently published the results of his geological labors among the

Southern Appalachians, which throw much light upon the probable age of the crystalline rocks of that region. It has long been the tendency of geologists to regard the metamorphic crystalline rocks of the Atlantic coast as certainly pre-Silurian. This has, however, been called in question by the observations of Professor Dana, which go to prove that the limestones and accompanying schists and quartzites of Western New England are *all* Silurian, and not Huronian nor Laurentian. Professor Bradley now claims the same for the region he has investigated, that is, the western portion of North Carolina, the eastern part of Tennessee, and much of Georgia and Alabama. The evidence upon which the conclusion is based is stratigraphical, and must be studied in detail to be fully understood. The time at which the uplift and metamorphism of this region took place is considered by Professor Bradley to have been post-carboniferous, and it is probably referable to the close of the paleozoic.

DISCOVERY OF A BED OF NICKEL IN NORWAY.

It is announced that a very rich bed of nickel has been recently discovered in the forest of Glörud, in Norway. The ore proves to contain 3.59 per cent. of pure metal, an exceptionally large proportion.—13 *A*, *September* 4, 1874, 263.

MAGNETIC SAND IN LABRADOR.

It is stated that, within a few years past, large quantities of magnetic iron ore, in sand, have been discovered on the north coast of Labrador, and that Mr. Lamothe, of Montreal, has more recently been engaged in bringing this to public notice. A company was formed, and forges were built at Moisie, which are now in operation, since when other localities have been determined along the north shore, especially at Matashquan, Kegashka, St. John River, and St. Marguerite. Several attempts have been made to purify this sand in a rapid and economical manner, and to make steel from the ore by a direct process, and these problems have now been solved by Professor Larne and Mr. Kizer, of Montreal. An establishment has also been erected at Block Point, between St. John River and Mingan, for the preparation of the sand and its exportation to Swansea. It contains, in the rough state, 30 per cent. of the magnetic iron, and when prepared

99 per cent. It is expected that thirty tons per day will be furnished at this place. Works for the manufacture of steel from this sand have been established at Quebec, and at Matashquan others are being put up. The ore is said to excel that of New Zealand in richness, and it is probable that before long it will occupy a permanent place in the iron industry.

INTERESTING PHENOMENA OBSERVED IN STONE QUARRIES.

Professor W. H. Niles, of the Boston Institute of Technology, communicates the results of further observations of the peculiar phenomena observed at the stone quarries at Monson, Massachusetts. Similar phenomena have been recorded once before by Professor Johnston, of Middletown, Connecticut, in relation to the sandstone quarries at Portland, in that state. Both these gentlemen concur in the same conclusion, namely, that the strata of sandstone at Portland and the strata of gneiss at Monson are not at the present time perfectly at ease in their ancient beds, but that, in some way, they have received a disposition to change their position slightly; that, in fact, they exist there in a state of compression, the force with which they tend to expand being so great that it has been known to break apart beds of the thickness of three, four, and five feet, for a distance of 100 feet or more; while in another case one end of a long prismoid of gneiss, being solidly attached to the undisturbed rock, the other end, by its expansion, pushed upward about 10,000 tons of rock. The expansions at Monson take place only in a northerly and southerly direction. The cracks and rents are generally formed slowly, but sometimes suddenly, attended by a loud report similar to that of a slight shock of earthquake, and sometimes by the throwing of stones of considerable size to the distance of several feet.—*Proc. Am. Assoc.*, I., 1873, 156.

CHANGES OF LEVEL ON THE COAST OF MAINE.

For many years there have been reports of changes in the depth of water on the rocks and shoals on the coast of Maine. From a report on this subject to the Superintendent of the Coast Survey, by Professor Shaler, the following facts have been gathered:

The natural indications of changes of level are the remains of marine animals found above the level of high-tide mark; the presence of extensive stratified deposits, at points where fresh-water lakes could have had nothing to do with their formation; and the existence of a characteristic topography not explicable on any other supposition than that of marine action. In his investigation of the coast of Maine, Professor Shaler has not been able to rely to any great extent upon the first of these three natural indications; the evidence afforded by the extensive stratified deposits has been to him the most important, both in its nature and its quantity. Taking the masses of stratified drift as the only acceptable and abundant proof of depression, he considers that we must look at the question of the origin of these bodies of drift and the possibility of their being formed by other agents than those which are at work in the sea. Some slight amount of stratification seems not inconsistent with the theory of the action of water in the formation of extensive sheets of drift; but when the stratified drift is distributed in extensive sheets along the shore, all doubt of marine action may be fairly put away.

The neighborhood of Boston, like the whole country southward to New York, is characterized by having a vast accumulation of drift materials disposed in four distinct formations, each indicating a separate stage of the glacier period; namely, first, massive drift in patches, which are the fragments of a great body of drift of great thickness left by the old glacier ice-sheets. This drift is quite without traces of stratification, and a large part of its pebbles are scarred by glacier scratches. Second, bodies of glacier material rudely distributed by water, the glacier scratches generally worn away from the surface of the pebbles, the whole indicating one or more of the processes by which the re-elevation of the country was effected after the passage of the glacier ice. Third, a secondary glacier series, indicating the recurrence of local depressions after the partial re-elevation of the country. These secondary glaciers in the neighborhood of Boston occupy only the larger stream-beds. Fourth, the rearranged beds lying within a few feet of the present level, which indicate a long-continued rest of the sea, at or near its present place. At this level the life-bearing bodies of drift come again into prominence. Fifth, the extensive mud-beds and marshes always colored by the remains of animals and plants. As we go southward from Boston we gradually pass to an area of increased table drift of indistinct stratification, and corresponding to the first of the preceding five geological epochs. At Portland we have decided evidence to show that the depression of the glacier period was 150 feet, or double that of Boston. East of Portland, and covering the country as far as New Brunswick, we have proof of the existence of a set of local glaciers covering the shore, and continuing until the final re-elevation of the land to near its present level. In some remarks upon the origin of the glacier epoch, Professor Shaler has recourse to the theory that our sun is a variable star.—*Mem. Bost. Nat. Hist. Soc.*, II., 1874, 321.

NEW MINING REGION IN NEW MEXICO AND ARIZONA.

The *Engineering and Mining Journal* quotes from a New Mexican paper an account of a very rich and extensive copper region lately opened in New Mexico and Arizona, in the vicinity of the White Mountain Indian Reservation, which from its importance seems likely to eclipse all other mining portions of the Southwest. This results partly from the great amount of ore of unsurpassed richness, and partly from the simple method by which the metal may be reduced. In the region referred to one solid wall of copper ore has been exposed for a distance of 250 feet, and from 10 to 15 feet in height, and of enormous width, yielding 70 per cent. of pure copper. Still larger veins have been found in the neighborhood.—17 *D*, *December* 12, 1874, 371.

PETROLEUM SPRINGS IN NORTH GERMANY.

Petroleum springs have lately been discovered in considerable quantity on the Lüneburg Heaths, in Northern Germany. The oil, in clearness, purity, and specific weight, is said to be identical with the American rock-oils, and it is almost without smell of any kind.—13 *A*, *November* 14, 1874, 532.

COAL-MINES IN RUSSIA.

Extensive coal-mines have been discovered in the Jekaterinoslaw district, in the lands of the Don Cossacks of Russia. These lie at a depth of about 200 feet, and the yield is so abundant that many thousands of tons have been shipped from the port of Taganrog. It is thought that this coal will answer an important purpose in connection with the Suez steam navigation, and in all probability drive out of use in that region the English coal which is now universally employed.—13 *A*, *November* 14, 1874, 532.

COAL-FIELD NEAR DRANISTA.

A coal-field has recently been explored by a party of English engineers near Dranista, which is about fifty miles southwest of the town of Salonica, and is inclosed by a range of mountains of crescent shape, commencing on the south at Mount Olympus, and terminating on the north at the bay of Kitros, in the Gulf of Salonica. An aggregate thickness of about eight feet of coal has been found, extending over an area of 2000 acres, although it is thought probable that the coal-field is of much greater extent, and that the basin contains 255,000,000 tons of coal of good quality.—13 *A*, *November* 14, 1874, 532.

GEOLOGY OF COSTA RICA.

Professor Gabb, in a communication to the *American Journal of Science*, gives some account of the geology of a portion of Costa Rica, which he has been engaged in exploring for some time past, and takes occasion to point out the fact that the highest peak in the country is not the Irazu, as has been generally supposed, but the Pico-Blanco, which he estimates at about 10,200 feet. From its summit large extents of both the Atlantic and Pacific are readily visible.

Geologically the Pico-Blanco is not a volcano, but a culminating point of granite intrusion from below miocene rocks. There is, however, a large mass of true volcanic rock forming the apex, which, nevertheless, is only a dike laid bare by denudation, and does not extend 300 feet below the summit.—4 *D*, *November*, 1874, 389.

FALLING OF ATMOSPHERIC DUST IN NORWAY, MARCH 29 AND 30, 1875.

Professor Daubrée communicates to the Academy of Science, in Paris, notes upon certain atmospheric dust which fell in Sweden and Norway in the nights of the 29th and 30th of March, 1875. This was found scattered over the snow, and was obtained by melting and evaporating the latter. The first impression on examining the dust was that it had a meteoric origin, representing a condition not unfrequently observed in the atmosphere. Careful investigation, however, finally induced the belief that this was a volcanic phenomenon, the dust being possibly derived from some eruption in Iceland. Professor Daubrée, in remarking upon the great distance to which volcanic and other ashes may be transported, states that a certain dry fog which covered nearly the whole of Europe, in 1783, was due to a volcanic eruption in Iceland; and that ashes from the Chicago fire fell on the Azores on the fourth day after that catastrophe. These gave out an empyreumatic odor, which induced the suggestion, at the time, that some great forest on the American continent must be on fire.—6 *B*, *April* 19, 1875, 995.

COAL IN THE STRAIT OF MAGELLAN.

An important discovery, if correctly represented, has lately been made in the opening of a rich coal-mine in the southern part of Patagonia, near Brunswick Island, in the Strait of Magellan, in the locality known as Captain Corey's Ranch, near the Chilian colony of Punta Arenas, in latitude 53° 9′ S. and longitude 73° 13′ W. The property referred to has been granted by the Chilian government to three French explorers, Messrs. Bouquet, Derue, and Suzainecourt. There are three distinct beds of the coal, of which one is about 300 feet above the level of the sea, of a minimum thickness of about 6½ feet. The second is from five to six feet in thickness, and is about 170 feet above the first. The third is about 130 feet above the second, with a thickness of 16 feet, divided into three nearly square layers, and separated by thin strata of slate. In view of the large number of steam-vessels annually traversing the Strait of Magellan, an unlimited supply of good coal in that locality is a matter of very great importance.—1 *B*, *October* 11, 1874, 17.

TIN IN NEW SOUTH WALES.

The tin-bearing country in New South Wales, of which so much was said a few years ago, still continues to be noteworthy for the extent and value of the take of this valuable metal. The amount raised in Inversall, which is but a small portion of the region where the metal occurs, amounts to about 800 tons during the past year. The principal mines are on Coke's Creek, Middle Creek, and MacIntyre River. The rocks are granite, greenstone trap, carboniferous beds, miocene, pliocene, quaternary, the latter including drift deposits. The stream tin is found in the drift as well as in the miocene, and valuable veins of tin ore occur in granite which is believed to be of upper carboniferous age.—4 *D*, *November*, 1874, 403.

GOLD IN EASTERN SIBERIA.

Gold was obtained during the year 1874, in large quantities, from the region of the Upper Amoor of Eastern Siberia. —13 *A*, *November* 14, 1874, 532.

ORIGIN OF THE RED CHALK AND THE RED CLAY.

Professor Church, in a recent number of the *Chemical News*, communicates an article upon the red chalk and the red clay, in which he points out a striking relationship between these substances as existing in England, and the gatherings in the recent deep-sea explorations from the bottom of the sea. We have already referred to Professor Thomson's explanation of the origin of the latter; and Professor Church gives us good reason to suspect a close parallelism in point of origin between the two, the chemical composition as well as physical character of the chalk agreeing very closely with those of the red residue obtained by Mr. Buchanan from the globigerina ooze, and those of the red smooth clay brought up from the deeper part of the sea bottom.

There are differences between the two, to which Professor Church adverts, but these, in his opinion, may be caused by subsequent conditions which we are at present unable to appreciate. Both substances appear to be entitled to the designation of a silicate of red oxide of iron and alumina, and to have been derived in all probability by the removal, in different degrees, of the calcareous matter from the original material. The question of the occurrence and origin of glauconite, a variable silicate of grayish green color, is also discussed; and the similarity caused by its presence between the cretaceous and greensand strata in Europe and America, to the recent greensands of the Australian seas and of the

Agulhas current, are considered. The precise problem of the forms of the recent greensands, or rather of glauconite matter, at given depths in the red clay, is not yet satisfactorily answered.—1 *A*, *May* 7, 199.

ZONOCHLORITE AND CHLORASTROLITE.

Some time ago, under the name of zonochlorite, Professor Foote described a mineral species found at Neepigon Bay, Lake Superior. This species has recently been re-examined by Mr. George W. Hawes, who placed thin sections of it under the microscope. It consists of green earthy particles disseminated in a white mineral, and hence is evidently not a true species, but a mixture. Analysis shows it to be essentially nothing but a very impure variety of prehnite. The chlorastrolite from Isle Royale has also been reinvestigated by Mr. Hawes, both chemically and microscopically. This, too, appears to be but a mixture similar to zonochlorite. Its specific gravity is somewhat higher than that of pure prehnite, a fact which Mr. Hawes thinks may be due to a slight admixture of epidote.

WAPPLERITE.

This new species is found at Joachimsthal, in crystalline crusts resembling hyalite, in small botryoidal aggregates, and in crude vitreous masses. It is a hydrated calcium arseniate, containing eight molecules of water. Three of these molecules are driven off by a temperature of 100° Centigrade, when, like pharmacolite, it is converted into haidingerite. Frenzel is the discoverer.

CLARITE.

Under this name Roemer describes a dimorphous modification of enargite, found in the Clara mine, near Schapbach, in the Baden Black Forest. Chemically it is enargite, but varies from the latter in color, density, and crystalline form. Clarite is dark, lead gray, and monoclinic; enargite is iron black, and rhombic.

CHALCOPHANITE.

Under the above name Dr. Gideon E. Moore describes a new mineral from the zinc mines at Stirling Hill, Ogdensburg, N. J. It occurs in druses, lining the walls and cavities, and also in foliated aggregates of minute crystals. The color is bluish black, lustre metallic, specific gravity 3.907. Its composition is very remarkable, since it contains zinc oxide, manganese monoxide and dioxide, and water. It is therefore a hydrate of manganese and zinc, containing the former metal in two states of oxidation. By heating it changes color, and becomes of a tint varying from yellowish bronze to copper red. The new mineral is apparently a product of the decomposition of franklinite and some of its associated species.

THE MASSACHUSETTS SILVER-LEAD MINES.

The following facts concerning the development of silver-mining in Massachusetts are given on the authority of Mr. C. W. Kempton, mining engineer, of Newburyport, Massachusetts. The mining region, according to the statement of this gentleman, extends from Gloucester, Massachusetts, on the south, to Portsmouth, New Hampshire, on the north, and from the Atlantic, on the east, to a line drawn north and south through "Great Pond," North Andover, Massachusetts, on the west. Within this region is located the first discovered, and thus far the most prominent lode — the "Chipman" — situated in the northerly part of Newburyport, and which has been traced for a distance of three miles. The dip is nearly vertical, and slightly to the north. The ore is chiefly galena, carrying from 50 to 150 ozs. of silver to the ton, with some gold, blende, copper, and pyrites. There is native silver in the quartz, and stephanite has been found. The Chipman and Boynton shafts are on this lode; the last named is down, at the time of this writing, some 100 feet. About $20,000 worth of galena ore was taken out of the Chipman at the start, in sinking the first 75 feet of the shaft. The average thickness of vein-rock on the Chipman lode is about 60 feet. The lode lies between granite on the north and slate on the south. There are not less than eleven parallel veins in this section of the mining district, on several of which mining operations have been commenced, showing well in the majority of cases.

Our informant likewise notices a second variety of ore, viz., the veins carrying tetrahedrite, which often runs exceedingly rich in silver. Of these, the "Bartlett" is spoken of as the most prominent, having an outcrop of vein-rock (limestone) something near to 100 feet in thickness. This vein is described as yielding an abundance of ore, carrying from 200 to 1100 ozs. of silver per ton, and 30 per cent. of copper. Several such gray copper veins are known, and lie in contact with porphyry. A third class of veins lies between the galena veins on the north and the porphyry on the south. They carry both galena and gray copper, but have not thus far been sufficiently investigated to enable an opinion to be formed as to their value.

LAKE AREA OF THE EOCENE AGE IN NEW MEXICO.

One of the most important results of the geological survey of New Mexico, conducted by Lieutenant G. M. Wheeler, United States Engineers, during the season of 1874, is the discovery by Professor Cope of an extensive lake deposit of the eocene age in the western and northern parts of that territory. The deposits cover at least three thousand square miles, and are three thousand feet in thickness, being worn into remarkable bad-land deserts in some localities. This is only the second lake area of this age discovered in the West, the survey under Clarence King having discovered the longest known, viz., that of Wyoming, some years ago. Professor Cope discovered the remains of about one hundred species of vertebrata, mostly mammals, in the New Mexican formations, many of them of peculiar character, and to a great extent different from those of the Wyoming eocene. Carnivora of an antiquated pattern were abundant, and hoofed animals related to the tapir. Eight species of an almost unknown order—the Toxodontia, which is related to rodents and elephants—were also found.

CHAMPLAIN DEPOSITS OF SOUTHERN NEW ENGLAND.

Professor Dana, in continuation of his essay upon the geology of the vicinity of Hartford, Connecticut, published in the *Journal of Science*, remarks that there are three prominent facts indicated by the Champlain deposits of Southern New England. First, the occurrence of a vast flood during the closing part of the melting of the glacier, in which other parts of New England participated; second, the absence of marine life from Long Island Sound through the glacial period and the early part of the Champlain period; third, a participation in the subsidence which affected the regions farther north. For all these he presents numerous data in evidence. He finds that while the glacial ice of the White Mountains was not less than 5800 feet, and perhaps even greater, in Southwestern Massachusetts it only extended to the height of about 2600 feet above the sea. Following out the more conclusive evidence, Professor Dana estimates the height, at New Haven, at from 1500 to 2000 feet. This, in his opinion, furnishes at the melting time material for swelling certain waters at least to universal floods. The sinking of the land that took place after the ice had reached its height, placing the site of Montreal five hundred feet below the sea-level, making Lake Champlain an arm of the great St. Lawrence Gulf, and other high latitude lands much below the present level, presents, he thinks, a sufficient reason for the change of climate which began the thinning of the glacier, and finally hurried on its dissolution.—4 *D*, *September*, p. 169.

GAS WELLS OF PENNSYLVANIA.

The opinion is daily growing more decided among those who are well informed that the gases which are constantly escaping from innumerable wells throughout the oil region of Pennsylvania and adjacent states, represent a value but little, if at all, inferior to the oil itself. The next step after the realization of this fact is its utilization; and, from occasional paragraphs that from time to time appear, there is reason to believe that the industrial employment of this material, of which inestimable volumes have for years been permitted to pass uselessly into the air, will soon become very general. In a few instances the wells have been tubed, and their product utilized with most satisfactory results. We add herewith the following from the *National Oil Journal*, which indicates that some progress is being made in this important field. The *Journal* remarks that the yield of the few gas wells that have been tubed shows that the quantity of the product is enormous beyond computation. A gas well near Sarnersville, in the Butler oil region, flows with a pressure of three hundred pounds to the square inch, and is roughly estimated to yield a million cubic feet of gas every twenty-four hours; and this is only one of many large gas wells, and almost numberless small ones; for it must be remembered that every well which produces oil yields gas also. A survey has just been completed for a line of pipe from Sarnersville to Pittsburgh, a distance of about seventeen miles. It is proposed to lay a six-inch pipe between the points named, and to supply the gas to the manufacturing establishments in Pittsburgh as a substitute for coal.

MELANOSIDERITE, A NEW MINERAL.

Professor Cooke, of Cambridge, has described a new mineral under the name of Melanosiderite. It is compact and amorphous, very brittle, and with a conchoidal fracture. Its lustre is vitreous, color black, and streak brownish-red. In hardness it lies between fluor-spar and apatite, and its specific gravity is 3.39. An analysis shows it to consist essentially of silica, iron, and water; and Professor Cooke regards it as a very basic silicate of iron, most closely allied to Hisingerite. It comes very near to the common sesquihydrates of iron, but its low specific gravity is regarded as showing a marked distinction from them. It was found in Chester County, Pa.

Professor Cooke has also continued his investigations of the vermiculites, and has described two new varieties, one from Delaware County, Pa., the other from Pelham, Mass. His labors on this group of minerals have led him to the conclusion that they are all unisilicates, and combine with water in several definite proportions, but that the only essential difference between them is in the ratio between the sesquioxide and protoxide bases.

F. GEOGRAPHY.

REPORT OF A RECONNAISSANCE OF NORTHWESTERN WYOMING.

The report of a reconnaissance of Northwestern Wyoming, made in the summer of 1873 by Captain William A. Jones, of the United States Engineers, has just been published by Congress in a volume of 210 pages, with a large number of plates. It embraces a descriptive journal of the route, which started at Fort Bridger, via the Shoshone Agency, and the valley of the Big Horn to Yellowstone Lake and the Three Tetons, and thence returned to Camp Brown.

The second chapter is specially devoted to the geography of the route, and especially that of the region about the Yellowstone Lake, previously reported upon by Dr. Hayden. There are also chapters on the meteorology of the region, an astronomical report, and a very detailed geological report by Professor Theodore B. Comstock. Dr. Heizmann, of the army, furnishes an account of the mineral and thermal waters. The botany is described by Dr. C. C. Parry, and the entomology by Mr. J. D. Putnam.

The most important result obtained by the expedition is the determination of a new and short route to the Yellowstone National Park, this being the result of the discovery of the Togwotee Pass, which permits a direct line to the region in question. This pass is at the head of Wind River, a little southeast from Yellowstone Lake, and constitutes a perfectly practicable passage to the Yellowstone Valley, via Wind River Valley. The other passes through the Sierra Shoshone are very difficult of transit.

Togwotee Pass is in latitude 43° 46′ 29″, longitude 110° 1′, and has an altitude of 9621 feet above the sea. Notwithstanding this altitude, the slopes approaching the summit are so long and regular that a railroad can be built over it at a reasonable cost. The route will be available at once for the construction of a wagon road.

The present route of travel to Montana leaves the Central Pacific Railroad at Corinne, and runs in a northerly direction through Idaho to Montana, crossing the Bannock Mountains on the divide between the Snake and the Missouri rivers. The distance from Corinne to Fort Ellis is 403 miles. The proposed road leaves the Union Pacific Railroad at Point of Rocks, Wyoming, and runs about north into the Wind River Valley, thence up that valley to its head, and through Togwotee Pass northerly to Yellowstone Lake, and through the Yellowstone National Park to Fort Ellis. This route passes all the principal curiosities of the National Park except the geysers, which can easily be reached by a short side road. By it the distance from Point of Rocks to Yellowstone Lake is 289 miles, and to Fort Ellis 437 miles.

The proposed route saves 250 miles of distance by railroad, 482 miles in reaching Yellowstone Lake, and 216 in reaching the principal cities in Montana. Besides this, it runs directly through the Yellowstone National Park, which at present is very inaccessible, and it will eventually be the shortest railroad line to Montana. It opens up a very large tract of low-lying timber land (about two millions of acres), and will prepare the way for the settlement of the Wind River Valley, the Teton Basin, and the valley of the Upper Yellowstone, and will finally throw open the Yellowstone National Park to the wonder-seekers of the world.

ON THE PROPER ARRANGEMENT OF GEODETIC TRIANGULATIONS.

In a recent Appendix to the Report of the Coast Survey, Mr. Schott says that whatever may be the design of any geodetic operation, it must be based upon a triangulation; and the greater or less complexity of the net-work of triangles will depend chiefly on the hypsometric features of the country. The adaptation of the triangulation to these various conditions, paying proper attention to accuracy, economy, and rapidity, requires especial consideration in each case. If the question is how to arrange the net-work of triangles in the most effective manner, we shall, in general, have to decide between one of four arrangements. A series may be formed of a single string or triangles, a double string or lozenges, a triple string or hexagons, and a quadruple string or quadrilaterals; or it may be composed of a more complicated combination. The single string is to be adopted when economy and rapidity are the first requisites; the hexagonal system when a large area is to be covered; a series of quadrilaterals is the system possessing the greatest strength or accuracy. The relative values of these three systems may be determined by the consideration that the first, or triangular, requires the least number of stations; the third, or quadrilateral, necessitates the shortest lines of sight, and therefore the least obstruction by fog, haze, woods, etc. Among auxiliary methods which are needed for short distances where ordinary triangulation can not be applied, if we do not resort to actual measurements of long lines with rods or wires or rolling-wheels, we adopt that of Struve, which consists in measuring a number of small base-lines at right angles to the main course of the triangulation, so as to have one within each of a series of elongated quadrilaterals.—*Appendix* XV., *Coast Survey Report*, 1871.

THE MEAN HEIGHT OF EUROPE ABOVE THE SEA LEVEL.

The mean height of Europe above the sea level has been recently determined by Leipoldt, who calculates that it is about equal to 297 meters, which is 92 meters higher than the calculation of Humboldt. The mean height of Great Britain is 218 meters, and of Switzerland 1300.

GEODESY IN SWITZERLAND.

From the report of the Natural History Society of Switzerland we gather that the publication of the three sections of the primary triangulation work is now nearly completed. During the past year experiments with Bessel's reversion pendulum have been carried out by Plantamour, and exact levelings made, in order to connect together the principal stations. These latter have been investigated by Redard, who has found an error in altitude of one meter in the earlier portion of the work, between Locarno and Domodossola, by the rectification of which there seems now reasonable certainty that the entire Alpine polygon will exhibit no sensible error.—*Ver. Schweiz. Natur. Gesell.*, 1874, 113.

TRIGONOMETRICAL SURVEY OF INDIA.

According to the annual report of the Indian Trigonometrical Survey, seventy principal triangles, embracing an area of 7200 square miles, and extending over a linear distance of 300 miles, have been measured. Of the topographical survey 3700 square miles have been executed. The southern section of the great Indian arc of the meridian has been completely revised, and Colonel Walker expresses his opinion that no portion of the principal triangulation remains which will ever be required to be revised, the last of the weak portions having been made strong and comparable with the best modern triangulation. In the course of the accurate work, determinations have been made of the rate of progress of certain sand hills near Cape Comorin. These travel progressively in a direction from west-northwest to east-southeast, which is that of the prevailing winds in this locality. They move at the rate of about seventeen yards per annum. Tidal observations are being made in the gulf of Kutch which promise to lead to valuable results. Very great difficulties were found in selecting suitable stations for fixing the tide-gauges—difficulties that were overcome only by sinking wells on the shore connected with the sea by open pipes, and in which wells the tide-gauges were set up.

THE HARBOR OF NEW YORK.

One of the most important recent contributions to the Coast Survey has been the renewed investigation of all the phenomena peculiar to New York Harbor, under the special direction of Professor Henry Mitchell. The physical survey of this harbor and its approaches require to be frequently renewed, in order to keep track of the numerous changes continually occurring both from natural and artificial causes. In the recent report of Professor Mitchell to the Superintendent of the Coast Survey, made in response to a resolution of the New York Chamber of Commerce, it is shown that the Jersey Flats no longer receive the deposits formerly carried by currents upon its interior space. In consequence, the deposits have accumulated to such an extent upon the fore slope of the bank that the flats are rapidly growing out into the main channel. If these flats are to be occupied by buildings, provision should be made specially for keeping a bold frontage. In the vicinity of Middle Ground Shoal and of Gowanus a similar movement outward seems to be taking place from a similar cause. The importance of the East River to the preservation of the entrance to New York Harbor is shown from the fact that the whole movement of water which flows into New York Harbor in the course of each tide through the East River is sufficient of itself to raise the water of the harbor by one and one-tenth feet. The turn of the tide in the East River occurs two hours after the ebb begins in the harbor, and during these two hours the flow is toward the East River instead of from it. As the result of some calculations, it is shown that the whole of the flow through the Narrows corresponds to five and three-tenth feet in elevation of the surface of the harbor, and this is the amount which would run through if the East River were to be cut off. An additional nine tenths of a foot, however, is to be added as due to that which comes from the East River itself, giving a total of six and two-tenth feet, representing the flow through the Narrows and over the bar. If, therefore, the East River were cut off, the corresponding decrease in the flow of water and decrease in the scouring of the bar would involve a reduction of the depth of water upon the bar of about three and a half feet. Therefore the loss of this river, or any obstruction to its flow or reduction of its capacity, become injurious to the harbor.—*Rept. U. S. Coast Survey*, 1871, 94.

THE DIFFERENCE OF LEVEL BETWEEN RARITAN BAY AND THE DELAWARE RIVER.

A line of leveling, seventy-seven miles long, has recently been extended by the Coast Survey from mean tide on Raritan Bay to mean tide at Gloucester City, on the Delaware River. Tides were observed at each station for the purpose of determining the true level of mean tide, which reference planes were fixed by means of permanent bench-marks established in the vicinity. These two bench-marks were made the termini of the line of levels. Every precaution, even to the extent of an entire re-leveling in an opposite direction, was taken for the purpose of avoiding all sources of error. The result has shown that the mean tide at Gloucester City is three feet five inches above the mean tide at Raritan Bay, which latter may be supposed to be the same as that of the ocean. In connection with this accurate leveling a series of barometric observations was made for the determination of the altitudes of neighboring geodetic stations, of which the highest, that at Yard Station, is 480 feet above the ocean.—*Rept. U. S. Coast Survey*, 1871, 175.

NEW ROUTE BETWEEN AUSTRALIA AND CHINA.

Captain Moresby has brought to the notice of the Royal Geographical Society a new route between Australia and China, which lies to the west instead of the east of the Louisiade Archipelago, and is shorter than the present line of communication by three hundred miles.—13 *A*, *March* 6, 1875, 243.

PROGRESS OF BAROMETRIC HYPSOMETRY.

That the investigations of Ruhlmann into the sources of error in the determination of altitudes by means of the barometer has been the beginning of a new epoch in barometric hypsometry is evident from the applause with which his work has been received, and the several attempts that have been made by various meteorologists to carry out the methods of observation recommended by him.

In this connection we notice the publication, by Mr. Schott and Mr. George Davidson, of a short comparative study of the methods of determining heights by means of leveling, of vertical angles, and of barometric measures. This investigation appears to have been begun in 1860, when the observations were first made at two stations about fifty miles northwest of San Francisco; the field work was only completed in 1872, and consisted of hourly observations from early morning until sunset, with meteorological and geodesic instruments. The observations have been carefully discussed by Mr. Schott, and he has arrived at the remarkable result that between these upper and lower stations, and during the period over which the observations extend, the temperature of the intervening stratum of air was nearly constant throughout the entire day. There seems, in fact, no trace of a daily variation, as though the rays of the sun passed through the air without sensibly heating it. For this location, therefore, we must conclude that the daily variation of temperature shown by ordinary thermometric readings belongs mainly to the layer of air in contact with or in close proximity to the earth's surface. The computed altitude of the upper station above the lower one, as compared with the true altitude deduced from careful levelings, shows that for an altitude of 2000 feet, and on the average of seven days' observations, the upper station is computed to be about eleven meters (that is, about thirty-five feet) too high. What the individual discordances are from these mean results is not stated; but judging from the similar results given by Ruhlmann, we are safe in saying that differences of altitude of 2000 feet can not be determined by the barometer within a hundred feet, unless the true temperature of the air is computed by Plantamour's or Ruhlmann's method, and is used instead of the observed temperatures directly given by thermometers. —*App. No.* 11 *U. S. Coast Survey,* 1871.

DECREASE OF WATER IN EUROPEAN RIVERS IN THE PRESENT CENTURY.

A suggestive paper has lately been communicated by Mr. W. G. Wex to the Geographical Society of Vienna upon the decrease of water in rivers and sources. The author states that the results of his observations tend to show the constant decrease of the rivers of Germany and an increase of the seas. They indicate that the levels of the German rivers are now much lower than they were fifty years ago, the Elbe having decreased to the amount of seventeen inches, the Rhine twenty-four, the Oder seventeen, the Vistula twenty-six, and the Danube fifty-five. The reason assigned for this is the progressing devastation of forests, which causes a decrease in the atmospheric moisture they attract and convey to the soil, and thence to sources of streams.—12 *A, February* 18, 1875, 314.

PHYSICAL PECULIARITIES OF THE UPPER VOLGA.

According to Poljakow, who has been exploring the region of the Upper Volga, under the patronage of the Russian Geographical Society, the Scandinavian Finlandic glacier, which at one time covered the Government of Olonez and those adjacent to it, must have stretched far into the basin of the Volga and over the boundaries of the Waldai plateau; and a connection must undoubtedly have existed between the Arctic and Baltic seas by the unequal levels of the lakes formed by the melting of the glacier, the slight remains of which are seen in the existing lakes.

Judging from the fauna, Poljakow concludes that the present upper course of the Volga must have been joined to the middle and lower course at a recent period, and in a measure accidentally. In this respect the Sheksna is to be considered the natural upper part of the Volga, as containing the very same fishes as those of the river Bjelosero.—12 *A*, *June* 17, 1875, 134.

PHYSICAL CHARACTER OF RODRIGUEZ.

We owe our first reliable information of Rodriguez to the members of the British party visiting that island for the purpose of making preparations for the transit of Venus. This part of the expedition was warned at the Mauritius that they must take every thing they required for subsistence, as it would be impossible to get any thing at Rodriguez. On reaching the island they found the vegetation very rank, the trees, however, of no great size, rarely forming a thick forest, but scattered singly over the slopes of the island. The most common tree seemed to be the vacoa (*Pandanus*), of which there appeared to be four species. The undershrub is very dense and spinous, rendering walking through it exceedingly unpleasant. Neither ferns nor mosses appear to be very abundant, but lichens are pretty plentiful. The rocks are largely columnar and basaltic, showing that at some period the island was exposed to volcanic action. Landing on the island was difficult, owing to the extent of the coral reefs.—12 *A*, *October* 29, 1874, 529.

EXPERIENCES OF THE "BASILISK" IN NEW GUINEA.

The recent experiences of the British surveying ship, the *Basilisk*, under Captain Moresby, to which we have already referred, have added greatly to our knowledge of the character of New Guinea and its inhabitants. To the three races heretofore known upon the island—namely, the Papuans on the south, the Arfaks of the mountainous country on the north, and the Malays of the northwest—Captain Moresby has added a fourth by the discovery of another, probably a mixed race of Malays and Papuans, inhabiting the whole of the eastern peninsula of New Guinea in its northern and southern shores, from about 148° longitude to East Cape, which is in 150° 53′, and the adjacent archipelago.

This race, while distinctly Malayan, differs from the pure Malay in being smaller in stature, coarser in feature, thicker lipped, and having more frizzled hair. The race merges into pure Papuan in the neighborhood of Cape Possession. They bury their dead in the ground, and build small thatched huts over them. Their houses, like those of the Papuans, are built on piles, and communicate with the ground by means of a pole notched with steps. They cultivate the ground pretty successfully, using stone mattocks for turning up the soil. Cannibalism appears to be known among them, but prevails only to a slight degree. The men are but slightly tattooed, while the women are tattooed all over in graceful patterns. Unlike the Papuans, they possess the art of making pottery. They are better fishermen than the Papuans, having a greater variety of implements, as well as of canoes. Up to the time of the visit of the *Basilisk* they seemed to have had very little acquaintance with white men.—12 *A*, *April* 24, 1875, 431.

MR. FORREST'S EXPLORATION OF AUSTRALIA.

Mr. John Forrest has succeeded in crossing from the western coast of Australia through the very heart of the only extensive region in Australia hitherto unexplored. He and his companions traveled nearly 2000 miles, keeping close to the twenty-sixth parallel of latitude. They left Champion Bay April 1, and reached the telegraph line September 27. Much of the country passed over was of the poorest possible description, scantily supplied with water. This achievement of Mr. Forrest leaves only the direct and more southern route to Perth to be traversed to complete the data requisite for making known the general character of the West Australian continent.—12 *A*, X., *December* 3, 1874, 93.

TOPOGRAPHY OF MICHIGAN.

In a pamphlet entitled "Popular Sketches of the Topography, Climate, and Geology of Michigan," Professor Winchell gives a table of the exact areas of the Great Lakes, which, according to him, are as follows, expressed in thousands of square miles: Superior, 32; Michigan, 20; Huron, 20; Erie, 6; Ontario, 6. The total length of lake shore-line within the State of Michigan is 1620 miles. He says that he has attempted to collect all the important information obtained, in running levels in railroad and canal surveys, and has obtained data for the heights of six thousand places, which give the levels of the surface of the state at every point along the lines of survey. The planes of reference have all been compared with each other with great care, and all elevations reduced to Chicago city datum, which is low water in Lake Michigan in 1847. Contour lines for every fifty feet of elevation above Lake Michigan have been drawn, and are represented upon the maps accompanying the pamphlet, which presents a good general picture of the surface configuration. These tortuous lines, which to the casual observer may seem to be of little interest or value, will be highly appreciated by every intelligent person, and especially by those engaged in engineering enterprises. From the map it appears that the lake shores are depressed, the surface swelling gently up toward the interior regions; the rise being one or two hundred feet within a few miles, and afterward much more gradual. A few bluffs and steep shores are presented between Saginaw Bay and Lake Huron; but in general the steepest grades are found in the eastern portions of the state. Along the border of Lake Michigan stretches a series of sand dunes, or piles of fine silicious sand, piled up by the easterly winds to a height of one or two hundred feet. Back of these dunes the surface is depressed, and frequently occupied by marshes and lagoons. The average elevation of the interior of Lower Michigan varies from four hundred to one thousand feet, with many marks of the erosions that in post-geological ages have pared down the original surface, and established the existing slopes of the land and even the bottom of the lake. Eighteen summits are enumerated by Professor Winchell. They are usually gently undulating plateaus, through which drainage valleys of moderate depth have been excavated. In the northern peninsula, owing to the want of accurate data, so minute a survey can not at present be entered into. The highest summit on the Marquette and Ontonagon is 1186 feet; while the hills north of Lake Michigama are 1215 feet above that lake; and other points near by reach 1250 feet. Beyond the Ontonagon River the greatest altitude of the Porcupine Mountains is quoted at 1380 feet. Especial attention is called to the fact that the longitudinal axes of the topographical and hydrographical feature of the state lie in directions which are diagonals between the cardinal points of the compass, showing, as Winchell thinks, that these axes are the resultant of two forces: a glacial force acting from the northeast, and a stratigraphical acting along the lines of strike of the rocky formations. The effect of the lake's temperature has received very full attention at the hands of Professor Winchell, who seems to have been the first to give us an exact idea of the great extent of that influence. Fifty-five meteorological stations in Michigan, and an almost equal number of stations in the neighboring states, have been employed by him in tracing out and marking the tortuosities of the isothermals of the lower peninsula of Michigan. The important facts disclosed by his researches in this respect have already been published widely in many journals, both in this country and in Europe; and these disclosures are destined to take their place among the most interesting phenomena of climatological science. In reference to the rainfall, he infers from the data at hand that the year 1871 was a year of remarkable dryness throughout the state.

THE TRIGONOMETRICAL SURVEY OF INDIA.

From the general report of the operations of the great trigonometrical survey of India during 1873 and 1874, we gather, that of the principal triangulation, seventy triangles, covering 7200 square miles, have been measured. The secondary triangulation extends over an area of 20,000 square miles, of which 5200 have been closely covered with points for use in plane table surveying. Of this latter an area of 500 square miles has been completed on a scale of one inch to the mile, and an area of 2400 square miles on a scale of two inches to the mile. The revision of the older portions of the triangulations has now been completed, and the whole of the work corresponds to the demands of modern science. Certain of the stations on the sand-hills formerly occupied by the observers having disappeared, it has been ascertained that these hills travel progressively in the same direction, W.N.W. to S.S.E., which is that of the prevailing winds in this locality. The rate of progression appears to be about fifty feet per annum; and this remarkable sand-wave, which has never yet been effectually resisted, notwithstanding numerous attempts by growing grass and trees on the sands themselves, has gradually overwhelmed the villages it has met in its course. The tidal observations made by the survey in the Gulf of Kutch can only be satisfactorily carried out by setting up the gauges on shore, over wells sunk near the high-water line, and connected with the sea by iron piping. The wells are twenty-two inches in diameter, and the piping two inches, which dimensions do not materially retard the tidal phenomena.

GEODETIC SIGNALS USED IN THE ADIRONDACK SURVEY.

In his interesting report on the survey of the Adirondack wilderness of New York, Mr. Verplanck Colvin explains the construction of a very simple signal which was used by him with success to replace the expensive heliostat. This arrangement was constructed of a vertical shaft, over which was suspended by wires four square sheets of ordinary highly polished tin, from which sheets respectively others were suspended at various angles with the horizon. When the sun was about rising or setting, the reflection from the surface of the vertical sheets of tin were sufficient to make this signal visible at a distance of twenty miles, and that, too, in every direction; since by the action of the wind this arrangement was kept constantly in rotation. Mirrors of glass were at first tried, but were too easily broken in transportation, while the sheets of tin were carried safely to all positions. In the survey of so rough a country as the Adirondack region, the delicate and expensive instruments required in the exact work of the Coast Survey could scarcely be employed, except at an unjustifiably great expense. Mr. Colvin's survey looks to the rapid preparation of sufficiently accurate maps of that region, based upon geodetic triangulation and barometric determinations of the altitudes of prominent points.

THE SARANAC EXPLORING EXPEDITION.

For the purpose of increasing the attractions of the ethnological exhibition at the Centennial, undertaken by the Indian Bureau and the Smithsonian Institution, the Secretary of the Navy directed the United States steamer *Saranac*, bound on a cruise to the North Pacific, to take on board at San Francisco Dr. Emil Bessels, the well-known surgeon of the *Polaris* expedition, to have charge of obtaining a full representation of the manners, habits, etc., of the Esquimaux of the northern possessions of the United States. He was accompanied by Lieutenant Maynard, of the Navy, who was the member of the commission ordered by Congress, two years ago, to investigate the trade of the north, and the relations of the Alaska Commercial Company to the natives.

The proposed plan of the cruise of the steamer was to proceed first to Sitka, for the purpose of coaling, and to collect such articles as could be found in that vicinity; thence to Kodiak by way of Cook's Inlet; then to Nunivak and the Pribylov group. Here a week was to be devoted to the investigation of prehistoric dwellings at the northeast end of Nunivak Island. After that the vessel was to proceed to St. Lawrence Island, and thence to the Seniavine Strait, southwest of Aracan Island, where the natives have an extensive trade with Americans by way of the Diomedes, they being of American extraction, and having left America at a comparatively recent date. It was also proposed to stop at the Diomede Islands, which are said to be thickly populated by Esquimaux, and afterward at Cape East, where a very large number of these people are reported to exist. Having investigated the Siberian coast, she was to pass over again to the American shore to Point Hope, which next to Nunivak may be considered as of the greatest importance in regard to ethnological significance. The northernmost point of the northwest coast to be touched at was Cape Lisburne, with its interesting deposits of palæozoic fossils, where a large harvest was expected. Should circumstances permit, the attempt was to be made to reach Wrangel's Land, which has never been landed upon. On the way back it was intended to stop at King's and Sledge Islands, where several native settlements are known to exist; and, after having passed a number of days among these Hyperboreans, the vessel was to proceed to Unalashka, whence a number of minor excursions were to be made, with the aid of the steam-launch accompanying the vessel, to the Chika Islands, in Akutan Pass. This was to have been the final work before her return to San Francisco.

The expedition was well provided with surveying and magnetic instruments, with photographic apparatus to obtain portraits of the natives, and a complete outfit for the collection of specimens of natural history. The scientific operations were intrusted to Dr. Emil Bessels, while Lieutenant W. Maynard had orders to continue his investigations in regard to the seal fisheries and the fur trade. The Indian Office placed $3000 at the disposal of the former to procure ethnological specimens for the Centennial Exhibition. It was also the intention to bring some natives of the different hyperborean tribes to the United States to be exhibited at Philadelphia, in order to have an opportunity for studying, with more leisure than a brief stay in their country would afford, their language, mythology, etc.

Unfortunately the cruise came to a sudden end. The *Saranac*, after having left San Francisco, encountered heavy headwinds, and had to run into Nanaimo, Vancouver Island, to coal. After a day's delay, she left this place on the evening of June 17th, and in attempting to enter Seymour Narrows, at about 8 o'clock the next morning, she struck the well-known rock near the middle of the channel, and sank in less than an hour. The accident was caused by the fact that the vessel would not obey her helm readily. The strong current, having at the time a velocity of about seven knots per hour, carried her with crushing force against the sunken rock. Hardly any thing could be saved, but owing to the excellent discipline no lives were lost. The officers and crew, numbering 173, landed safely with the ship's boat on the shore of Vancouver Island; but as the cliffs were too steep to afford a good camping-ground, both provisions and camp were transferred to Valdisc Island, which was found to be more suitable. In the mean time the executive officer of the lost vessel was dispatched to Victoria, with a boat's crew, to obtain assistance. After the lapse of five days of continual rain, during which the shipwrecked mariners were almost without shelter and on very scanty rations, the English man-of-war *Myrmidon* made her appearance, followed by the H. B. C. steamer *Otter*, to convey the officers and men to Victoria. The courteous and generous treatment of the party by the English naval officers can not be too highly spoken of.

EXPLORATIONS UNDER DR. HAYDEN IN 1875.

The United States Geological and Geographical Survey of the Territories, under the direction of Professor Hayden, during the season of 1875 continued its work of the two previous seasons in Colorado, completing the southern and southwestern portions, including a belt fifteen miles in width of Northern New Mexico and Eastern Utah.

The entire force of the survey was divided into seven parties for special duty, four of which were assigned to specific areas, for the performance of topographical and geological work. One party attended to the primary triangulation, a second collected photographic views of the most interesting scenery and ancient ruins, while a third transported the supplies to the various districts.

The areas for exploration the present season were much farther from the base of supplies than heretofore, rendering the labor greater, and causing great loss of time in traveling to and from these bases. Yet the amount of topographical and geological work accomplished has not been exceeded in any previous year.

As heretofore, the starting-point was at Denver. The first or southern division operated in Southeastern Colorado. It was composed of A. D. Wilson, chief topographer, directing; Franklin Rhoda, assistant topographer; Dr. F. M. Endlich, geologist, with two packers and a cook. The district surveyed by this party embraced an area of 12,400 square miles. Within these limits Mr. Wilson made one hundred and forty-three stations on the more commanding peaks.

A system of triangles was extended over the whole area, while at the same time the topographical sketches and angles were taken, barometrical readings were made at all occupied points, at all camps, passes, and other places of note visited during the season. Many of the stations have been carefully connected in height by fore and back angles of elevation and depression, to be used as a check on the barometric heights, while the height of all located points has been determined by a system of angles of depression and elevation.

The district assigned to this division for the summer of 1875 joined on to the south borders of that surveyed in

1873 and 1874. The 104° 30′ longitude formed the eastern, 108° longitude the western, and 36° 45′ north latitude the southern boundaries. About 12,400 square miles were contained in the district.

A plan for the most rapid and successful completion of the work undertaken was prepared by Mr. Wilson, and subsequently carried out as proposed. This district contained the foot-hills sloping eastward from the Front Range, the southern continuation of the Sangre de Christo Range, the southern end of the San Luis Valley, the extension of the La Plata Mountains, and the lower country of the Rio San Juan and its tributaries. A small portion of the sedimentary eastern foot-hills was first surveyed, and the work then carried westward to the mountainous vicinity of the Upper Rio Grande. Instead of forming a well-defined, sharply limited range, the mountains south of the Rio Grande are formed by a high plateau with numerous isolated peaks. Both plateau and the peaks mentioned are volcanic, showing the characteristic regularity of flows prevalent there. From the position of volcanic beds composing the higher peaks, it may be inferred that at one time the summit of the plateau extended to a considerably higher altitude than at present. Toward the southwest it drops off suddenly into the lower country containing Rios Piedra and Pinos. Presenting a line of steep, rough mountains, formed in part by the abrupt termination of the plateau, in part by the peaks above mentioned, the former contrasts strongly with the rich land in the valleys of the two rivers. Here, as at so many points in the districts surveyed by the southern division, the geological features determine the orographic character. With the plateau end, the volcanic beds and the sedimentaries of the cretaceous age set in. But few stratigraphical disturbances have changed the relative position of the beds, and the country, therefore, shows regular features. Long lines of high ridges, abrupt on the north side, sloping more gently toward the south, extend from east to west, and are cut by the drainage of the San Juan. Eastward the edge of the plateau recedes, losing at the same time some of its roughness, and a broad expanse of comparatively low bluff country appears. Rich valleys, partly timbered or covered with grass, follow the course of the larger streams, owing their formations to the rapid erosions and ready disintegration of the shales belonging to Cretaceous No. 2. Springs containing an unusual amount of mineral ingredients, some of them hot, occur in these valleys. Owing to the slight southerly dip of the cretaceous beds, this formation claims a considerable area of the region, extending from the Rio Animas eastward to the border of the district. Above the well-determined strata of Nos. 2 and 3, a series of shales and sandstones set in, in which no characteristic fossils whatever were found. They reach a thickness of about three thousand feet, and contain coal at a number of points. It will not be possible to determine their geological age with any degree of certainty, until careful comparison of the parallel formations observed by Mr. Holmes and Dr. Peale can be made. The absence of fossils is greatly to be regretted; but none were found, although many square miles were traversed containing the series. Speaking with the reserve that imperfect comparison of the notes taken dictates, it would appear that the Trinidad coal-bearing series is parallel to this one.

After having completed the survey of this lower region along the Rio San Juan and its tributaries, the work was continued to the extension of the La Plata Mountains. Here again volcanic rocks were met with, identical in every respect with those farther north and west. Here, as well as previously on the headwaters of the Pinos and Piedra, evidence of former glaciers was found. Considerable areas showed the grooving and striation of rocks *in positu*, produced by the motion of ice and boulders. Deep cañons were cut into the volcanic conglomerate occurring there, that had not preserved grooving and striation however, owing to the rapidity with which it yields to the effect of atmospheric influence. A gentle slope eastward of the volcanic rocks, that there reached to the youngest member of the group—basalt —gradually merged into the San Luis Valley. Affected by local basaltic eruptions, as well as by the easterly dip of the volcanic beds, the drainage on the west side of this valley presents some interesting features, consisting in sudden curves northward. Northward, the unbroken flows of basalt continue on the west side of the valley until Rio Alamosa is reached, where they end and drift begins. A number of volcanic bluffs, trending nearly north and south, separate this portion from the valley through which the Rio Grande runs, after making its turn southward, west of Fort Garland. This region, geologically, is more interesting than the western one, on account of the evidence furnished demonstrating the existence of two very large lakes at the close of the volcanic activity there. The two were connected by a narrow strip of water south of Fort Garland, and the lower one extended southward nearly to the Rio Colorado. At that time, too, the course of the Rio Grande was different from its present one. By the formation of a narrow cañon in the basaltic beds, the course of the river was deflected, the lakes drained, and the topography left very nearly in the shape we now observe it. The accurate determination of all the points connected with the existence of these lakes offers no material obstacle, but requires far more time than could be bestowed upon it in the regular course of the survey.

Separating the eastern foot-hills and the great plains from the San Luis Valley is the southern continuation of the Sangre de Christo Range. Several peaks of this range rise to an elevation of nearly fourteen thousand feet, while many of them reach thirteen thousand feet above sea level. Here again metamorphic rocks set in, containing indications of metalliferous veins. Sedimentary beds, belonging to the carboniferous and cretaceous ages—the latter only on the eastern slope, however—rest against the metamorphic "core" of the range. Volcanic eruptions of the trachytic series have occurred, and show an arrangement parallel to the general course of the chain. A more or less isolated group of peaks lies north of Fort Garland, termed the Sierra Blanca. Passes are both north and south of it—Mosco Pass, and the Sangre de Christo and Abeyta Passes. While cretaceous beds overlying the carboniferous, and showing considerable disturbances, slope off from the range toward the eastward, their area is somewhat limited, as the lignitic group there again makes its appearance in the Raton Hills and north of them. Lithologically this is identical with the one observed on the Rio San Juan. Comparisons of the succession of strata and relative thickness, etc., will be found in the report for 1875. The age of this group has for some time occupied the attention of geologists, and given occasion for dissenting views. It is highly probable that the results obtained during the past season will admit of a definite decision with regard thereto. They will at least be entitled to more consideration than those of explorers who have merely traveled over a limited area, as so large a continuous district containing the formation has been examined. It is not possible at present to state positively what these results will be, but from the observations taken in the field it can be deduced that the age of the lignitic group near Trinidad is *not* cretaceous. A full discussion of this important subject will be found in the report for 1875.

Upon the completion of the examination of the just-mentioned group, the work of the season was connected to the north and northeast with that of 1874, and therewith finished. On October 12th the party returned to Denver, having fully accomplished the purpose for which it was sent out. Important and useful information has been obtained regarding the mineral and agricultural resources of the district, and data have been obtained for the preparation of a topographical and geological map of the area surveyed.

The southwestern division was conducted by W. H. Holmes as geologist, with G. P. Chittenden as chief topographer, and T. S. Brandegee as assistant topographer. Mr. Brandegee acted as botanist also.

The area assigned to this division is bounded on the east by the work done by Mr. Wilson in 1874, or a line about on the meridian of 108° W. long., on the south by the parallel of 36° 45′, on the west by meridian 109° 30′, and on the north by 37° 30′ N. lat. These boundaries included an area of about six thousand five hundred square miles. An area of about five hundred square miles was surveyed on the eastern base of the mountains on the outward march. Here Mr. Chittenden made about twelve stations, connecting with the former work, and completing the sheets to the proposed eastern line of the survey.

The easternmost line of the district assigned to this division was over four hundred miles from Denver. The party arrived there on the 30th of June, and commenced work immediately.

The work was generally done by means of the plane table, and reinforced by both vertical and drainage sketches from all the stations, and also by time meanders of all the main streams, and generally by a running sketch of the routes traveled. The main stations averaged *one to every seventy-five square miles* of area.

By meandering, Mr. Chittenden surveyed the San Juan River, the La Plata, the Mancos, and the Dolores, all of them considerable streams, and besides these also the McElmo and Montezuma Creeks, which, though well-defined stream-beds, contain no running water. These last-named dry rivers are each upward of seventy-five miles long, and for a considerable part of their course are in deep cañons. In the meanders he made a trigonometric location as often as once in ten miles.

The great trouble in working was lack of water. They were often obliged to ride out ten, fifteen, and even twenty miles from the rivers to make a station, and back again for camp, because outside of the rivers themselves there was no water at all.

In regard to the systems of working generally employed now in the different surveys west of the Missouri River, the plane table system, which was generally used this summer, is admirably adapted to a low, broken country where good "points" are abundant, and works also extremely well in a simple cañon country, where there are surrounding prominent points at not too great distances. But in a mountainous country it could not be used to any advantage, and was eventually abandoned in all the mountain work. In low, broken, and cañon country it is probably the best system that can be used; but in the ordinary rolling and mountainous country of the Northwest it will not repay the extra weight and time which its use entails.

In any but a very mountainous country a system of *meanders* seems to be almost necessary to make work on a scale of four miles to an inch complete. It is the abuse and not the use of the old odometer system that has brought it into so much discredit. If properly checked, the meanders give the more important portions of the country, as the traveled routes and principal rivers, the greater degree of accuracy which is their due. The third and only remaining system in use in the West is that generally employed on this survey, and formerly used both in the California Survey and in that of the 40th parallel. It consists of a system of vertical and horizontal sketches, based on a rather elaborate triangulation, and checked by numerous angles both vertical and horizontal. This system is peculiarly adapted to a rolling or mountainous country, and in such a country can not be equaled by either of the other modes. It works well, too, in districts of different character, and is probably, on the whole, the best system on which to base work in the average country of the West. It should, however, be supplemented by good meanders of all the main roads and rivers. In the work of the survey this summer the three systems were employed, and the above remarks are the immediate result of the summer's observations.

The party completed about six thousand square miles in the West, being obliged after the trouble with the Indians to leave unworked a small corner in the northwest, which will require about five days to complete. This patch joins directly on to Mr. Gannett's uncompleted area, and lies entirely west of the Colorado line. In going to and from the work, six full weeks were spent in marching. Mr. Chittenden worked about six thousand five hundred square miles, and made eighty-four main stations.

The geological examination by Mr. Holmes was fruitful of most important results. His investigations were extended from Colorado into portions of Utah, Arizona, and New Mexico.

No previous study of this region had been made, excepting that by Dr. Newberry in 1859, of which nothing has been published up to this time.

In 1874 Dr. Endlich examined the district lying to the east, so that Mr. Holmes took up the work where he left off at 108° W. long., and carried it without difficulty to 109° 30′. In general the geology is not greatly complicated. The section of stratified rocks exposed extends from the lignitic series to the carboniferous, including about two thousand feet of the former, and slight exposures merely of the latter. About eight thousand feet of strata, therefore, passed under examination. Of other rocks, there are four small areas of trachyte, one limited area of metamorphic rock, and a few unimportant dikes.

Beginning at the east, Dr. Endlich's section on meridian 108° includes the entire series, beginning with the lower carboniferous in the north and extending up into the tertiary at the south. The strike is east and west, the dip south from 5° to 45°. Working to the westward, Mr. Holmes found the whole series flattening out, *i. e.*, approaching a horizontal position. At the same time a gentle rise toward the northwest brings the cretaceous rocks to the surface, or at least up to the general level of the country. The lignitic group is, therefore, confined to the southeast. From Station 1 an outcrop of the light-colored sandstones, belonging to the base of this series, could be traced along its entire course through his district.

The heaviest seam of coal examined in these beds is twenty-six feet in thickness. It is rather light and impure on the surface, but probably of moderately good quality. A number of less important seams could also be recognized.

West of the Rio La Plata the upper cretaceous beds are raised to a higher plain by a slight monoclinal fold, after which they spread out to the west, forming the Mésa Verdé. This plateau extends nearly to the San Juan on the south, west beyond the Rio Mancos, and north to the middle of the district, an area of more than seven hundred square miles. On these three sides the Mésa breaks abruptly off in lines of irregular escarped cliffs, generally from one thousand to two thousand feet in height.

The striking features of this series are the exposure of two horizons of massive sandstones. The upper forms the top of the Mésa, the lower, one thousand feet below, produces a subordinate shelf. Shales intervene between the sandstones of the lignitic and the upper sandstones of the Mésa, and between these and the lower sandstones. Around the base of the Mésa the lower cretaceous shales outcrop. The belt covered by these is narrow, and is followed by the hard sandstones of the Dakota group, which is very persistent here as elsewhere, and occupies the higher level of the entire Mésa country to the west and north. The Jurassic strata and the "Red Beds" are exposed in the sides and bottoms of the numerous cañons and stream courses, the latter only in the greater valleys, and in patches about the bases of the trachytic areas. The Jurassic section is, in the upper part, almost identical with the corresponding series in other parts of Colorado, but at the base has a larger development of soft sandstones and marls. The identification rests upon the analogy of position and lithology. The "Red Beds" are massive sandstones and conglomerates as usual.

The only important mountains are the Sierra La Plata. They lie toward the northeast, and are principally of carboniferous rocks, so highly metamorphosed as to have lost all apparent structure. A large number of rich lodes of gold and silver have been recently discovered in this group about the sources of the Rio La Plata, and an extensive placer bar is located near its exit from the mountains.

In the extreme northeast corner of this district there is a group of trachytic buttes, including Lone Cone, which belong to the San Miguel Mountains. West of the Mésa Verdé, almost in the centre of the district, stands the "Late" group, of which Ute Peak is the culminating summit. It covers an area of some forty square miles, and is simply a mass of trachyte pushed up through and poured out over the floor of the Dakota group.

In the extreme southwest corner, principally in Arizona, are the Sierra Carisso, identical with the "Late" in nearly every respect, differing only in having carried up portions of the carboniferous rocks about their base, while a fragment of the same beds is caught up in the centre of the group.

Of the 6000 square miles, 5700 are of sedimentary rocks. Two hundred and thirty of these, in the southeast, are of the so-called lignitic; 800, chiefly included in the Mésa Verdé, belong to the upper cretaceous; and the remaining 4900 to the lower cretaceous, and such of the earlier periods as are exposed in the crooked and narrow valleys, and about the trachytic groups. In the cretaceous series Mr. Holmes examined a number of seams of workable coal, procured fossils in ten distinct horizons, and expects to be able to identify these horizons with such corresponding ones on the Atlantic slope. The section obtained is the most complete and satisfactory made in Colorado up to this time. The trachyte areas include about 250 square miles, and seem to present no remarkable or unusual features.

The prehistoric remains in the cañons and lowlands of the southwest are of great interest, and the study of them by Mr. Holmes was as complete as possible under the circumstances. Many cliff-houses, built in extraordinary situations, and still in a fine state of preservation, were examined. A good collection of pottery, stone implements—the latter including arrow-heads, axes, and ear ornaments, etc.—some pieces of rope, fragments of matting, water jars, corn and beans, and other articles, were exhumed from the débris of a house. Many graves were found, and a number of skulls and skeletons, that may fairly be attributed to the prehistoric inhabitants, were added to the collection.

The Western or Grand River Division consisted of Henry Gannett, topographer-in-charge, W. R. Atkinson, assistant topographer, A. C. Peale, geologist, two packers, and a cook.

The district assigned to this party lies between the parallels of latitude 37° 52′ and 39° 15′; is limited on the west by the meridian 109° 30′, and on the east by the western limit of the work of last year, approximately the Gunnison and Uncompahgre Rivers. This embraces the country drained by the Uncompahgre and Dolores Rivers and their branches.

The party left Denver on June 7th, and on July 3d commenced work. They worked uninterruptedly until August 15th, when the work was brought to a sudden close by the Indians.

The work was carried to the western line of Colorado, toward the northern end extending 25 or 30 miles into Utah, and reaching the north and south lines throughout, except in the southwestern part. The total area surveyed is about 6000 square miles. In doing this 74 stations were made.

The country is extremely diversified. The Uncompahgre flows through a broad valley, fifty miles in length by about twenty in width, almost perfectly flat, and very dry. The elevation is 4500 to 6000 feet. The soil is poor, and vegetation, except in the river bottom, very scanty.

Between the Uncompahgre and Dolores is a high ridge, whose axis is parallel to the course of the river, *i. e.*, about N. 30° W. It has a long, gradual slope to the Uncompahgre valley, while it breaks off sharply and steeply to the Dolores. The average elevation of the crest is 8000 to 9000 feet. Most of this country is well timbered with heavy pine, quaking aspen, and some spruce. There is also considerable open country, which is covered with luxuriant grass.

The Sierra La Sal is a short, isolated range of mountains, just west of the Dolores, separating it from the Grand River.

The direction of the range is about north and south, its length about fifteen miles, and the elevation of the summits 12,000 to 12,500 feet.

The Grand River, from the mouth of the Gunnison to that of the Dolores, is alternately in open valley and low cañon. On the south the river hugs the edge of the plateau closely, while on the north low, open desert country extends about fifteen miles back from the river. This desert country extends down the Grand and across to the Green, forming the Great Plateau in which these streams and the Colorado cut their cañons.

South of the Sierra La Sal are fine valleys, extending nearly to the head of the Dolores. Farther west the country is a plateau, without water, covered with sage and pinion pine, and cut by numberless dry cañons.

The geological features of the district surveyed by the Grand River Division during the season of 1875 are comparatively simple, there being no great uplifts nor many local disturbances. The sedimentary formations represented are all included under carboniferous, red beds (triassic ?), Jurassic, and cretaceous. Exposures of metamorphic rocks are seen in several parts of the district, limited mainly to the bottoms of cañons, the streams having cut through the overlying sedimentaries. The eruptive areas are also limited. In the southern part of the district there are the overlapping edges of various trachytic flows, whose sources of origin were in the Uncompahgre Mountains still farther south. Besides these there are three distinct centres of eruption: viz., the Lone Cone group of mountains on the south, the Abajo Mountains in the southwest, and the Sierra La Sal Mountains toward the northwest. These are of porphyritic trachyte, and have been pushed up through the cretaceous layers which dip gently from them. The greater part of the district, however, is covered with sedimentary rocks, generally horizontal, or, if dipping, but little inclined. In these beds the drainage is outlined by cañons which are from a few hundred to over a thousand feet in depth. During the summer months these streams are dry.

Leaving the Los Pinos Indian Agency, the first work was on the south side of the Gunnison River, in a narrow strip of country lying between Mr. Gannett's district of 1874 and that of Mr. Wilson for the same year. The rocks here are trachytes, interlaminated with tuffs in horizontal layers. They rest partly on metamorphic rocks and partly on the remnants of cretaceous sandstones. Previous to the outpourings of these trachytes, the country was evidently subjected to considerable erosion, the sandstones being in many places entirely removed, exposing the gneissic rocks upon which they were deposited. Going westward toward the Uncompahgre River, the volcanic rocks disappear, and rocks of upper cretaceous age show in bluffs on the east side. The weathering of these beds has produced a barren alkaline soil, in which there is no vegetation. In the immediate river bottom there is some good soil, but it is limited in extent. The course of the Uncompahgre is a few degrees west of north, and between it and the drainage of the San Miguel and Dolores Rivers, which has, approximately, the same direction, is a plateau-like country with a gentle slope to the eastward toward the Uncompahgre, and breaking off in benches on the Dolores side. Seen from the mountains, this plateau appears very regular, nevertheless it is very much cut up by numerous cañons, which carry water only in wet seasons. The floor of the plateau is composed chiefly of sandstone of the Dakota group (Cretaceous No. 1), underlaid by Jurassic shales and red beds (triassic?), which rest upon metamorphic rocks, as seen in the cañons. On the western side of the plateau is a monoclinal fold, which in some places becomes a fault of 300 to 500 feet.

One of the most curious features of this region is a cañon extending from the Dolores River to the Gunnison River. It is evidently the bed of an old stream, which probably once flowed toward the Gunnison. At present there are in it two creeks, one a tributary of the Gunnison, and the other a branch of the Dolores, the latter the principal stream of the two. At the divide between them the cañon is about 1200 feet deep, 900 feet of gneissic rock and 300 of sedimentaries on the top. The dip is toward the east, and the creek, flowing in that direction, gradually gets higher and higher in the schists, and finally cuts through the overlying sandstones in which it joins the Gunnison. Toward the west the cañon rapidly increases in depth, until it is 3000 feet below the general surface. The stream on this side cuts across the line of faulting of the west side of the plateau, and enters the red sandstones which incline westward. In these it joins the Dolores River. North of the cañon, between it and Grand River, the Dakota group, which prevails to the southward, is almost entirely absent, the red beds forming the greater part of the surface, which is here a maze of dry cañons. The country gradually falls off toward Grand River; the western line of faulting becomes a fold, and the eastern fold, which is also faulted in places, gradually becomes less. North of Grand River beds of upper cretaceous age appear, probably succeeded by tertiary as we go north. On the San Miguel and Dolores Rivers, and extending westward, the rocks are sandstones. There are broad folds extending across the country, whose axes are parallel, the general direction being north and south. Between the San Mignel and Dolores, the Dakota group forms the floor. Beyond the Dolores the red beds prevail, capped with isolated patches of Jurassic shales, and underlaid with beds of carboniferous age. The latter show but in few places. The drainage here has two general courses at right angles to each other. The main streams flow in a general northerly direction.

In the Sierra La Sal the prevailing rock is a beautiful porphyritic trachyte, which in some places has included masses of cretaceous shales. One of the most prominent peaks has a capping of sandstone, which was lifted up by the eruption of the mass, the base of the peak being entirely of trachyte. There are evidences of glacial action here. Northwest and west of the group the red beds have the Roches Moutonnés form, beautifully seen from the summits of the mountains.

The Abajo Mountains are of porphyritic trachyte similar to the Sierra La Sal, as are the mountains about Lone Cone, which properly belong to the district assigned to the San Juan Division.

The work of the Fourth Division, directed by G. R. Bechler, extended over a large area, situated between meridians 104° 30′ and 106° 30′, and parallels 38° 40′ and 40° 30′; or from the foot-hills of the Rocky Mountains to the Upper Arkansas and Eagle Rivers, and from a point six miles south of Pike's Peak to within fifteen miles of Long's Peak.

In this district the entire Middle and South Parks are located, and three of the large rivers of the west—the Arkansas, Grand, and Platte Rivers—together with several of their large tributaries, have their origin. The principal branches are the Blue, Snake, Williamson, and Frazer Rivers on the west slope, and Tarryall, Fountain of the Bouillie, Bear, Clear, St. Vrain, Boulder, Thompson, and Buckhorn Rivers on the eastern slope.

The main Rocky Range and its minor ranges are in this district peculiarly complicated, for the latter, at times, on account of their height and magnitude, seem to lose their subordinate character and become independent ranges, while the main range contains groups or clusters of peaks so complicated in their form and connection that it requires close observation on the part of the topographer to lay down the true drainage.

Among the minor ranges, the Park, Williams or Blue River, Gore's, Tarryall, and Platte River ranges rank in height among the largest, while for extreme ruggedness the Gore and Tarryall Mountains can not well be surpassed. In this district the great mining industries of Colorado are found.

The geographical features of this area are as follows: Between the Argentine and Georgia Passes a ridge of mountains leaves the main chain and follows a course about southeast, and connects with the mountains near the Pike's Peak group on its west side. This is the Tarryall Range, a rugged and abrupt granite wall, with several peaks over 12,500 feet in height, and most of the others rising above timber line. The greatest depressions in this range are where the Tarryall and South Platte Rivers break through in cañons, and where the Ute Pass and Kanosha Pass afford an entrance to the South Park. To the east of the Kanosha Pass, a few miles, the Tarryall Range separates into two ridges, which run nearly in an eastern direction. The northern ridge borders the south side of the North Platte River, and is called the Kanosha, or Platte River Range. In this ridge volcanic peaks are found in great numbers. The mountain ranges in this portion of Colorado continually throw off spurs which are remarkable for the deep gorges which have been worn down their sides.

After completing the survey of Platte River, Tarryall, and the South Park districts, Mr. Bechler ascended the Arkansas Valley, crossed the Tennessee Pass, and examined the country that lies between the Eagle and Blue Rivers, of which very little was known. This territory is bounded on the south by the imposing mountain masses of the Mount Lincoln group, and on the east by the cliff walls of the Blue River Range, and on the northeast by Gore's Range, with its needle-shaped peaks extending for twenty miles like sharp pinnacles.

In completing the survey of this district, Mr. Bechler joined, by his topographical work and triangulation, three separate surveys of previous years.

Crossing Gore's Range and the Blue River, Mr. Bechler passed through the Middle Park and over the Boulder Pass to the sources of the Big Thompson Creek, an important stream rising on the east side of the Long's Peak group. Much excellent work was done in the ridges or hog-backs at the east base of the mountains, thus bringing the season's labors to a most successful termination. One hundred and six stations were made, barometrical elevations were four hundred and fifty, and the number of elevations taken with the gradienter were about six thousand.

The party under Mr. Gardner had made but four stations when it was prevented from further prosecution of that duty by Indians. One of the stations occupied was very important, viz., the Sierra La Sal Mountain, which enabled Mr. Gardner to secure an excellent set of observations, thus extending the triangulation far into Utah, and connecting our eastern work with the great Colorado River of the West.

During the latter part of the season of 1874 Mr. W. H. Jackson, the photographer of the United States Geological Survey, in connection with Mr. Ernst Ingersoll, visited the southwestern portion of Colorado for the purpose of photographing the ruins which rumor has placed in the cañons of the Mésa Verdé and about El Late. The season was far advanced, and there was but little time for investigation, yet the eight days that were actually devoted to the subject brought to light a group of ancient habitations, so novel in their construction and position that they have excited a very general interest. The results of the trip, as published in the correspondence of that time, and in Bulletin No. 1 of the Survey, have already been widely distributed. The illustrations secured by photography, and then reproduced by photo-lithographic processes, have done much to popularize and render familiar the leading features of the subject, showing as they do all the phases of the eccentric methods of these ancient builders, have made them an authority, and they have already been reproduced in a number of late publications.

The first trip proving so successful, Mr. Jackson was dispatched again this season to the same region, with instructions to ascertain as far as possible the extent and distribution of these ruins north of the present Moquis Pueblos. Associated with him in the enterprise was Mr. E. A. Barber, special correspondent of the New York *Herald.* A guide, two packers, and a cook constituted the whole party; and then, with six weeks' supplies laid in, the party started out from Parrott City, at the head of the Rio La Plata, August 27th, the general course being down the Rio San Juan to the De Chelly, up that to near Fort Defiance, and then over to the seven Moqui "Cities." Returning, they crossed the San Juan at the mouth of the De Chelly, and traveled northward to midway between the Sierra Abajo and La Sal, and then returned to the starting-point across the heads of the cañons which run southward to the San Juan.

The Upper San Juan, Mésa Verdé, and El Late regions came within the area assigned Mr. W. H. Holmes, who, in addition to his geological investigations, made a special examination of the archæology of his region, bringing out with his ready and artistic pencil even more wonderful ruins (of the same general class however) than were found by Mr. Jackson the previous season.

Traveling westward to the head of the wash of the McElmo, a day was spent in the further investigation of that interesting locality. A number of new ruins were discovered, but in no way differing from those already figured. The extreme heat of the atmosphere and the aridity of the country prevented more than a superficial examination of the many side cañons which debouch into the main one, only enough to determine satisfactorily that ruins were to be found only in those cañons which had alluvial bottoms or in the near vicinity of tillable land. This fact held good in the other regions, for in no case could a single vestige of any habitation be found in the sterile, rocky gorges any way removed from cultivatable ground. Their ideas of good farming land would hardly come up to that of an Eastern farmer, yet a strip of bottom land only fifty yards in width at the bottom of their deep cañons would yield maize enough to subsist quite a town. The supposition that they were an agricultural people is strengthened by the fact that in the vicinity of any group of ruins there are also a number of little "cubby-holes," too small for habitations, and very evidently intended for "caches," or granaries, and the large towns contain small apartments that must have been used for the same purpose.

The only known water in the country, short of the San Juan, over forty miles distant, was on the Hovenweep, near the town which was discovered last year, thus necessitating the retraversing of so much of the country. A day spent in some of the tributary cañons developed no remains of any importance, although every little side cañon contains traces of former occupation by the town-builders. To the west of the Hovenweep is a high, level plateau separating it from the cañons of the Montezuma, and running north and south from the waters of the San Juan to those of the Dolores. Upon this were found the remains of many circular towers, all of about the same size—twelve to fifteen feet in diameter. They are generally almost entirely obliterated; but in two or three cases portions of the wall twelve to fifteen feet high, of well-built masonry, were found. This arid sandstone mésa, a thousand feet above the surrounding valleys, does not contain a spring or any water whatever, except such as collects in the water-pockets during a shower. The soil upon its surface is thin, and in places is blown off clean to the bed rock. Grass, cedar, and artemisia flourish; in fact, it is most excellent grazing land, and, as cultivation was out of the question, these people must have had herds of sheep or goats, which they brought up here to graze during the winter months, just as the Utes and Navajos do at the present time, and these towers were built as places of refuge or residence for their herders.

Eight and ten miles below the Hovenweep town are two groups of ruins worthy of note. The first is built upon an almost perfectly rectangular block of sandstone which occupies a prominent position on a spur of the mésa. It is thirty-eight by thirty-two feet square, and twenty feet in height, as true and as level as though set by masons. The summit is entirely covered with the work that was built upon it, very evidently for merely defensive purposes, for directly at the foot of the rock at its south side was the habitation of the family. A line of wall forty feet square incloses a space, within which was another building resting against the rock itself, the roof of which served as a means of access to the rock above. Two miles below, where the McElmo comes in, and upon the point of the mésa, are other similar ruins, but built much less regularly. Upon one of the faces of the rock is an inscription, chipped in with some sharp pointed instrument, and covering some sixty square feet of surface. Figures of goats, lizards, and human figures abound, with many hieroglyphical signs. The top of the mésa afforded much food for speculation in the interesting remains there discovered. The extreme point was a perfectly flat, level table, fifty by one hundred yards in diameter, with perpendicular walls of from fifty to one hundred feet on all sides, excepting the narrow neck which connected it with the main plateau. Across this neck a wall had been built to keep off either human or beast, and rendered the place perfectly isolated. Inside, nearly the whole space was subdivided into small squares and double-walled circles formed by slabs of stone set on edge, each square about three by five feet. The supposition has always been that these were burial places. They were dug down upon to a considerable depth without discovering any remains; and as the soil was thin and light, so that the labor of excavation was easy, a number of the squares were cleaned out to the bed rock beneath, which in some cases was not more than a foot below, but without discovering any thing more than that in every case the earth had been burned and a thin layer of charcoal remained. The question arises as to whether these people might not have been cremationists.

The Rio San Juan at the mouth of the McElmo is a stream averaging one hundred feet in width and three to five in depth, flowing in great curves that almost touch upon themselves again, and bordered with dense groves of cottonwood. The bottoms are from one to three miles in width, and run back over sage-covered benches to the sandstone bluffs, picturesque in outline and color, which rise from five hundred to one thousand feet above the river. They gradually close in upon the stream, until it is finally lost in the great cañon below the mouth of the De Chelly.

Twelve or fifteen miles down the river brought the party to the first important ruins, although the older, almost unrecognized "indications" were abundant every where. At that point the bench land juts up over the river, and almost upon the brink is a quadrangular structure one hundred and sixty by one hundred and twenty feet square, with a small open court facing the river. A singular feature in its construction was a semicircular apartment in the centre of the building and rear of the court, about the outer circle of which was ranged a series of seven other apartments, each about four by six feet square. There were six other rooms averaging thirty-five by fifty feet. Under the bluffs and almost overhanging the stream were a row of little cave houses. Other cave houses were niched in the cave-like recesses of the bluffs for some distance above and below.

Some ten miles farther and the bordering bluffs came down quite near the stream, in some places overhanging it. Cave and cliff ruins occurred frequently in them. Upon the south side of the river an important cave ruin was discovered, which was quite remarkable in its way. Imagine a perpendicular bluff nearly three hundred feet in height, the upper half of which is a firm white sandstone, and the lower half a dull red, soft and friable variety. Time has excavated an almost perfectly hemispherical cave from this bluff, equally divided between the two kinds of rock. It is two hundred and fifty feet wide, two hundred feet deep, and the same from top to bottom at its outer face. Midway from top to bottom, and running completely around the half circle, which formed the back of the cave, are two benches, upon the upper of which is built the town or series of rooms, two hundred feet in length in the aggregate, the lower serving as a walk or promenade, from which access could only be had by ladders. A little to the left of the centre is the principal building, consisting of three rooms, each two stories in height, and now standing twelve feet high. Adjoining it on the right is a long row of twelve apartments, built as a solid block, and on the left an open space of sixteen feet, and then another small building. In the open space were four holes, four inches in diameter and twelve deep, drilled into the rock, serving evidently as post holes for a loom. All the rooms have been burned out clean, so that not a vestige of woodwork remains. The walls are remarkably well preserved, the adobe mortar on the inside still retaining the impression of the delicate lines on the thumbs and fingers of the hands of the builders. Impressions of the whole of the hand were frequent, showing it to be small and finely formed. Corn cobs and pieces of pottery were found imbedded in the mortar. In the centre of the larger rooms, beneath the débris, were found the fire-places, circular excavations, which still retained the charred wood and ashes of aboriginal fires.

Perched up in one of the houses, under a great dome of overhanging rock, that distinctly echoed every word uttered, with a steep descent of over one hundred feet to the broad, fertile bottoms, handsome groves, and meandering course of the river, these old, old people, whom even the imagination can hardly clothe with reality, must have felt a sense of security that even the inroads of the barbarian Northmen could hardly have ruffled.

Omitting mention of large numbers of ruins which are clustered along the San Juan, the next important group discovered—for this is the first time any of these have been brought before the world—were those of the Rio De Chelly. The party reached this point August 7th, the very hottest portion of the year, in a region noted for the intensity of the scorching rays which radiate from its bare plateau of white sandstone. The average temperature throughout the day, in the sun, was 140°. The temperature of the water in the river, in the midst of a rapid current, was 88°, and that was the coldest water to be had.

The Rio De Chelly, for a distance of about thirty-five miles above its mouth, is so cañoned, and the wash—for the bed of the stream is perfectly dry the greater portion of the year—cuts from wall rock to wall rock so frequently, that it is impossible to travel up it, except in the bed, and that is so tortuous and rocky in places that it would be difficult, if not impossible. Making a detour to the right, the first opening into the cañon was reached ten miles above. In here an interesting and extensive ruin was found, which was so well preserved that it seemed to have been vacated less than a score of years, and so near like the workmanship and manner of building of the present Moquis that it would not be difficult to imagine them lurking among the deserted rooms. This ruin was situated in a long cave-like bench, or mésa, running along the face of a perpendicular bluff, some fifty feet above its base, and has a total length of nearly 300 yards. The town was irregularly but compactly built, conforming to the rock upon which it is placed, the rooms arranged in a single row most of the way, but at either end bunching up to two or three deep. A ground-plan shows seventy-five rooms, with many little irregular "cubby-holes," with a total length of 548 feet. A few yards farther to the right are half a dozen detached buildings. Cisterns and reservoirs yet remain perfect enough to show their purpose. In the centre of the mass was a well-preserved circular apartment, a little below the general level of the others, that was probably an *estufa*. The great corrals were inside, between the houses and the bluff. Digging beneath the débris, several pieces of finely preserved pottery were found, the same finely ornamented and glazed ware of which the fragments are so universally scattered over the whole country. Beneath the centre of the town there was found in one group some whole jars, of about two gallons' capacity each, of the gray indented ware, but they were too fragile to transport upon pack-mules. Besides the pottery, many stone implements and arrow-points were unearthed. Another detour to the right, this time over an elevated plateau of white sandstone, across which were drifted great dunes of white sand, brought the party to the famous, so called, diamond-fields of Arizona, about which there was such an excitement in 1872. Lingering on its bare, red plain, upon which the sun beat with great intensity, only long enough to gather about a pint of garnets, which were of excellent quality and very abundant, camp was made at the foot of a side cañon which came in from the west, and was known as the Cañon Bonito Chiquito. Another group of ruins occurred here, not in a large town, but in scattered houses both up and down the De Chelly and Bonito. A marked feature were great reservoirs, in which there was, even now, abundant and excellent water. Two or three miles below, in the cañon of the main stream, was a well-preserved two-story house, standing upon a bench elevated fifty feet above the valley, and overhung by a great roof of rock that effectually shielded it from the storms. Near by was a great natural reservoir filled with good water. Another five or six miles and the cañon of the De Chelly opened out into a great valley, from one to three miles in width, and extending up to the foot of the great cañon near Fort Defiance. Twenty-five to thirty-five miles above the Bonito are some peculiar table-rocks and monuments that form notable landmarks. The ruins are now scarce, only a few being met with in the caves at the side of the valley. The bottom lands bear the impress of very numerous ruins—adobie very likely—that are now almost entirely obliterated, and would hardly be noticed were it not for the broken pottery.

At the head of the valley of the De Chelly the trail turned off to the southwest just above the upper edge of the great white mésa. Taking only two others, Mr. Barber and Lee, the guide, and sending the remainder of the train back some fifty miles, where there was suitable grazing, Mr. Jackson continued over to the Moquis Pueblos, seventy-five miles distant, with only the photographic apparatus and supplies for five days. Tequa was reached by noon of the following day. As these Pueblos have been so frequently described and illustrated, the party spent only two days and a half among the six most easterly towns, viz., Tequa, Se-chum-e-way, Moqui, Moo-sha-neh, Shong-a-pah-wee, and She-paul-a-wee. Photographs of each of these were made, and also many sketches illustrating their habits, dress, and occupations. Collections of recent and ancient pottery and tools, and other objects of interest, were likewise secured. The comparison between the workmanship of the northern town-builders and these Moquis was very much in favor of the former. The highest perfection was reached in the cliff-houses of the Rio Mancos, where some of the houses were marvels of finish and durability; and then, traveling toward the Moquis, there is a gradual merging of one style into the other, from the neatly cut rock and correct angles to the comparatively crude buildings now inhabited.

Retracing their steps to the San Juan, at the mouth of the

De Chelly, the party now traveled northward toward the Sierra Abajo, up a stream known as Epsom Creek, from the water which is found near its head tasting and operating like that salt. The usual indefinite ruins which occur on the lowlands continued up this valley over thirty miles. To the west was a labyrinth of cañons running off into those of the Great Colorado, an examination of some of which discovered many cave and cliff houses and towns, all of the same general type as the others. The ruins gradually diminished as they approached the Sierra Abajo, and several days spent in the examination of the cañons and plateaus about it and the Sierra La Sal failed to bring to light any more evidence of their occupation.

Nearly opposite the Sierra Abajo, or Blue Mountains, as they are locally known, heads the great cañons and valley of the Montezuma, which empties into the San Juan. Here the bottoms of the cañons have once supported a very thickly settled community. There is almost a continuous series of ruins for a distance of twenty-five miles. This in one cañon only, but all the others contain numerous remains, chiefly in cliff houses and towns. In the main cañon, first spoken of, are two ruins notable for the size of the stones employed in their construction. In one, built upon a small isolated tableland in the middle of the valley, are stones set upon end, six feet in length by eighteen inches square, and ranged along the walls a distance of twenty-five or thirty yards. Another case is where stones seven feet in height (above ground), and twenty inches square, are standing perpendicularly about five feet apart, and form one side of a wall inclosing the ruins of a large, important building. Throughout the cañons every available defensive point has been utilized, and are now covered with the remains of heavy walls and large blocks of houses. Another singular feature was the number of holes cut into the perpendicular lower wall of the cañon for the purpose of ascending the rock, holes just large enough to give a hand and foot hold, and leading either to some walled-up cave or to a building erected above. Some of these steps ascended the nearly perpendicular face of the rock for 150 or 200 feet. On exposed surfaces disintegration has almost entirely weathered away the holes, while on more protected walls they are deep enough to still answer their original purpose. The main western branch of the Montezuma contains the greater number and more important ruins of all the northern tributaries of the San Juan west of the Rio Mancos. Water was found in a few pools near its head and lower down, running along in a small stream a distance of two or three miles, when it sank again. The bottoms are rich, and the present Indians, Utes, who occupy the country, raise good crops of corn without irrigation.

The results of this trip was the collection of a large number of utensils, both modern and ancient, stone arrow and spear points, knives and axes, photographs, especially illustrative of the most important ruins, and numerous sketches of every thing of note, which will be brought out in detail in the regular publications of the Survey.

EXPLORATIONS UNDER MAJOR J. W. POWELL IN 1875.

The work of the Second Division of the United States Geological and Geographical Survey of the Territories, under the direction of Major J. W. Powell, has been in progress continuously since 1868 (during the earlier years under other titles), and prior to the present year an extensive region had been explored and partially surveyed. A stage of the work had been reached at which it was deemed best that a review of the geology should be made, for the purpose of establishing with greater accuracy the natural series of geological formations of sedimentary origin distributed through the fields of study already occupied, that the work of the several observers might be properly correlated. A small party was organized for this purpose, and led by Major Powell himself.

The main party under Professor A. H. Thompson, geographer of the Division, continued the work during the past season in the territory of Utah over an area of nearly 10,000 square miles, stretching from the Henry Mountains on the north to the Kaiparowits Plateau on the south, and from the Colorado River on the east to the Aquarius Plateau on the west.

A system of triangles projected from the Gunnison baseline has been connected with those made in earlier years from the Kanab base-line.

A primary hypsometric base-station was established at

Provo, on the Utah Southern Railroad, and a secondary base-station at Camp Supply, on the Dirty Devil River.

Plane-table methods were used in the topographic work. The plane table devised by Professor Thompson for this special work, after three years' experience, proves to be satisfactory, and is believed to greatly increase the accuracy of the work over the earlier methods of sketching and descriptive field-notes. Free-hand sketches and profile sketches were used as accessory methods in delineating the topographic features.

The classification of the lands begun in former years was continued during the past year; and it was found that of the lands surveyed during the past season, one fourth of one per cent. belongs to the first class, *i. e.*, lands which can be redeemed by irrigation; about fifty per cent. to the second class, *i. e.*, pasture lands; about nine per cent. to the third class, *i. e.*, timber lands; four per cent. to the fourth class, *i. e.*, mineral lands; and the remainder to the fifth class, *i. e.*, desert lands.

Geology.—Mr. G. K. Gilbert accompanied Professor Thompson's party as geologist. His prime subject of study was structural geology; that is, the magnitude and characteristics of the displacements by which rock-beds, originally level, have been brought to their present uneven condition. This study also involved an examination of the succession of strata, and incidentally full material for a geological map has been accumulated. A second and closely allied subject of study has been the eruptions that produced the Henry Mountains; a third has been the erosion by which the structure has been laid bare, and a fourth the Salina Creek unconformity.

The investigation at Salina Creek was of a special nature, and its bearings can not be briefly stated. Its result establishes a single point of geological history: namely, that an epoch of mountain growth, of which evidences are found in the Sevier and San Pete valleys, and in the Pah-van Mountains, occurred about the end of the Cretaceous period.

A line drawn from the Mu-si-ni-a Plateau southward to the eastern margin of the Aquarius Plateau separates a region of faults at the west from a region of folds at the east. Faults and folds are not distinct types of displacement, but merely different phases of the same action, and it is usual to find them associated; but in this instance the faults are restricted in distribution. There is some reason to suppose that the folding was of more ancient date and extended through the whole area, and that the faults were superimposed over a part.

The folds are large and small, and of various forms. The larger are great elongated domes, from which the strata dip in all directions. The smaller dapple the surface of the larger like a ripple riding on an ocean swell. One of the chief swells extends from Thousand Lake Mountain, one hundred miles in a southeast direction, its remote end lying between the Colorado and San Juan Rivers near their junction. Its greatest width is thirty miles, and its height, if the crest had not been eroded away, would be 7500 feet. Its western slope is gentle and its eastern steep, so that the crest runs close to the eastern base. Another of the same breadth lies at the north of this, extending far into the basin of the San Rafael River. Its form is different, however, for its summit is broad and flat, and both of its sides are steep. The trend of its longer axis, too, has a different course (southwest), diverging sixty degrees from that of the other. A third, of even more imposing proportions, lies to the east of these, beyond the field of survey; and between them are domes of smaller size. All of these swells have been so demolished by the agents of erosion that there remain of them only low arches of rock encircled by parallel lines of inward facing cliffs.

In the regions of faults there are great displacements and small, and the small are often, just as in the other region, subsidiary features of the great. The earth's crust is there divided into a great number of oblong blocks with vertical sides, and these blocks have slipped out of their original places, some going up, some going down, many being tipped this way or that, as though an end had caught while it was moving. At the north the tops of the higher blocks have been worn away, and their positions and limits can be ascertained only by careful study of the rocks. But at the south the whole surface was covered by a thick lava sheet before it was divided into blocks; each block is protected from erosion by its cap of tough, hard lava; every mountain is a block upthrust, every valley is a block depressed;

and the whole structure of the country is exhibited in its reliefs.

The eruptions of the Henry Mountains are of exceeding interest. A description of a single one, though it will not stand for all, will serve to illustrate the type.

Mount Ellsworth is round, and its base is six or eight miles broad. The strata of the plain about it are horizontal on every side, except at one point. At its base the level strata become slightly inclined, rising from all sides toward the mountain. Near the mountain the dip steadily increases, until on the steep flanks it reaches a maximum of forty-five degrees. Then it begins to diminish, and the strata arch over the crest in a complete dome. But the top of the dome has cracked open, and tapering fissures have run out to the flanks, and they have been filled with molten rock, which has congealed and formed dikes. Moreover, the curving strata of sandstone and shale have in places cleaved apart, and admitted sheets of lava between them. So the mountain is a dome or bubble of sedimentary rocks, with an eruptive core, with a system of radial dikes, and with a system of dikes interleaved with the strata; it is a mountain of uplifted strata, distended and suffused by eruptive rock.

The stratified rocks examined range in age from Carboniferous to Tertiary. Upon the geological map the combined Trias and Jura will cover half the space; the volcanic area will come next in size, and after that the Cretaceous. The excellence of the topographic work will enable a very thorough delineation of their boundaries. Fossils were found in numerous localities, but no large collection was made. Coal of Cretaceous Age was seen in abundance, but no other valuable mineral.

At the request of Major Powell, Captain C. E. Dutton, of the Ordnance Corps, was directed by the Secretary of War to accompany the former to his field of survey, and was engaged in the examination of a large tract consisting of igneous rocks. It lies in Southern Utah, its northern boundary being about 150 miles south of Salt Lake City, extending thence southward about 85 miles, having a breadth of about 60 miles. It consists of a series of long, narrow tables with intervening valleys, and is structurally a repetition of those features described by Major Powell as characteristic of the whole of Southern Utah and Northern Arizona, and which led him to call it the Plateau Province. The tables are cut from the platforms of the valleys by immense faults, and uplifted 2000 to 5500 feet above the valley plains, presenting nearly vertical walls fringed at their bases by rugged foot-hills. The plateaus are composed of thick beds of igneous rocks, well stratified and nearly horizontal; the foot-hills on the contrary are composed of beds much broken and disturbed, and intermixed with lavas. The southern portions are overlaid by a conglomerate, which commences near the middle of the region with a thickness of at least 2300 feet, and diminishes southward to 700 or 800 feet. It is composed wholly of igneous fragments, often of great size, inclosed in a matrix of sand and clay. In the southern portion it is underlaid by red sandstone and white marl of Tertiary Age, in the middle portion by rocks of the porphyrite class. The northern and higher portion consists of well-stratified rocks, having the mineral characters in some places of trachyte, in others of rhyolite, but with a structural habit, a texture and general mode of occurrence very unusual in these kinds of rock. Lava beds occur abundantly, but so far as observed are restricted to the foot-hills and valleys, and have evidently originated from the vicinity of the great faults. Captain Dutton inclines to the opinion that the stratified tabular masses were metamorphosed *in situ* from sedimentary beds. This inference is founded, first, upon the striking similarity in the structure of the igneous strata to that of the adjoining sedimentaries—a similarity in many cases exact even to small details; second, upon the absence of volcanic structure in the arrangement of the beds, and in their texture; third, upon the abundant occurrence of rocks which, when serially arranged, exhibit many stages of a progressive metamorphosis; also the occurrence of many large masses which can not be classified, except upon the assumption that they are imperfectly metamorphosed sedimentaries; fourth, the admission that they are eruptive renders the general problems of structure obscure, while if they are metamorphic the structure is a problem no longer, but merely a repetition of well-known features occurring every where in the country round about. The metamorphic origin of some porphyries has long been conceded, but the trachytes and rhyolites have always been considered volcanic. If these latter rocks are also in the present case metamorphic, the fact will be an important addition to volcanology. Captain Dutton is also engaged in the investigation of the micro-structure of the rocks of this region, and has made considerable progress in the preparation of specimens for microscopic examination.

At the beginning of the fiscal year Professor C. A. White, of Bowdoin College, was appointed paleontologist of the Division, and he immediately joined Major Powell's special party, mentioned above. This party visited many points in Northern Utah, a few in Northwestern Colorado, and a few in Southern Wyoming, making a re-examination of the sedimentary beds of that region, and the evidences upon which they had been previously separated into groups. Many localities where fossils had been obtained in previous years were visited, and other localities discovered. The collections made were from the upper portions of the Carboniferous group, through the whole series to near the summit of the Tertiary. The collections are chiefly of invertebrate fossils, and are very full and satisfactory.

Many new species, and also several types hitherto unknown in American strata, have been obtained. Among the latter may be mentioned a species of Unio, of the recent type of *U. clava*, Lam., and two types of Viviparine shells from near the base of the Tertiary, the layers containing them alternating with others containing *Ostrea* and other brackish-water forms. These facts, in connection with others already known, show that much differentiation had taken place in those families respectively very early in the Tertiary period, if not before. It is an interesting fact, also, that while a change from a salt or brackish water condition of the earlier Tertiary deposits to a wholly fresh-water condition took place without producing any perceptible physical change in the character of the strata, the species, mostly molluscan, were more numerous, and the differentiation of types much greater during the prevalence of salt in the water than at any subsequent time after the waters became wholly fresh. His notes also show that in all the purely fresh-water strata of all the Tertiary groups the species and genera are few, and there is a remarkable uniformity of type throughout. Both branchiferous and pulmonate mollusks range through all the Tertiary strata, except that they have thus far found none of the latter associated with brackish-water forms. Geophila were obtained from the Green River and Bridger Groups only. These comprise three or four genera of *Helicedæ.*

The Green River Group has furnished several species of insects.

Of vertebrate remains, some massive fragments of bones of a very large saurian, found in Jurassic strata five miles west of Vermilion Cañon, are worthy of remark. Scales and detached bones of teliost fishes were found in considerable abundance in dark shales at the very base of the Cretaceous group at Vermilion Cañon, and also at various other points on the same horizon. Teliost fish remains, mostly very perfect, were obtained from the Green River Group, and also some from other Tertiary strata. Throughout the whole Tertiary series more or less vertebrate remains have been found; but it is the Bridger Group that has furnished the greatest profusion of mammalian, besides many reptilian and a few ganoid remains.

Part of a skeleton of a Passerine bird has been obtained from the Green River Group.

Large collections of plants have been made at numerous localities. Besides samples of silicified exogenous wood from numerous horizons throughout the Mesozoic and Tertiary series, leaves, fruits, etc., have been collected from the upper Cretaceous and Tertiary strata. These are mostly exogens, but both ferns and palms were found associated with them in the upper Green River Group at Alkali Stage Station, twenty miles northward from Green River City.

Ethnography.—Professor Thompson's party discovered the ruins of many prehistoric dwellings similar to those found in former years, and their position will be indicated on the ethnographic map. He also discovered on the cañon walls and rock escarpments of the country many Shi-nu-mo etchings, which were copied to scale. They will make a valuable addition to the collection of former years.

While on his travels Major Powell met with certain tribes of Shoshoni Indians, whose arts were unrepresented in the National Museum, and the opportunity was seized upon to make collections of their implements, clothing, etc. In all departments, except that of food-plants, these Indians are now so fully represented as the Utes or Pai-Utes by his former collections. Some additions were made to his Shoshoni vocabularies and to his mythological tales.

Botany.—Mr. L. F. Ward was attached to the Division as botanist, and made a very large collection from a region but hitherto little studied. He also collected a large suite of wood sections of the various shrubs and trees found in the region.

Photographs.—Mr. J. K. Hillers, the photographer, made 101 negatives for topographic and geological purposes, and 10 for ethnographic.

Altogether, Major Powell considers that the result of the year's labor has been more satisfactory than that of any previous year.

EXPLORATIONS AND SURVEYS UNDER LIEUTENANT GEORGE M. WHEELER, U. S. ARMY, IN 1875.

Field parties were organized in the latter part of May for duty during those months when operations can be carried on in the higher altitudes of Colorado, New Mexico, California, Nevada, and Arizona. The office-work, as usual, continued in Washington.

The expedition of the year was made co-existent in three several sections: 1, California Section, starting from Los Angeles as an initial point; 2, Colorado Section, from Pueblo, Colorado; and, 3, the section on work being regularly carried on at the office in Washington.

The parties sent out from Pueblo disbanded at West Las Animas, near Fort Lyon, on the Arkansas, about November 20th; and those dispatched from Los Angeles, California, rendezvoused at the close of the season at Caliente, California, the present terminus of the Southern Pacific Railroad, with the exception of the party under Lieutenant Bergland, engaged in temporary office duties at Los Angeles, after the return of its members from their duties in the valley of the Colorado River, or rather that portion thereof lying to the southward of the great bend of this stream.

The California Section consisted of three main parties, the first under the command of the officer in charge, Lieutenant Wheeler; another, destined for the Death Valley region, under Lieutenant Rogers Birnie, Jr., 13th U. S. Infantry;

and the third in charge of Lieutenant C. W. Whipple, Ordnance Corps, U. S. A. A separate party, under Lieutenant Eric Bergland, Corps of Engineers, was engaged upon the banks of the Colorado River, with the special end in view of determining whether within certain limits of the Grand Cañon of the Colorado this stream could be diverted from its present channel, with a view to utilizing its waters in a system or systems of irrigation.

The reports received to date, although not final, confirm the idea that within the line of this portion of its flow—namely, from a point at the foot of the Grand Cañon to the Needles, below Camp Mojare—no practicable points were discovered at which the river could be taken from its present bed *with utility* for irrigating the comparatively desert wastes on either hand, or any of the valleys known to be of an arable character. Further examinations will be prosecuted during the winter in the valley of the Lower Colorado, with a view to determining as to the practicability of points in this portion of the river at which its waters might be diverted, and with what practical results; and also as to whether a series of lakes might or might not be used as links in the chain of communication that would be formed should this great stream be transferred from its present cañon bed to one of an alluvial character. Taking into account the ratio of evaporation from surfaces of water in these arid regions, the maximum size of the lake surfaces necessary to retain all the waters of this stream in reservoir might be determined, and the comparison of this aggregate area to that of the areas of depression found to exist along a line of transit, should such new channel be formed, can be ascertained.

A special party, acting in co-operation with one dispatched by the Smithsonian Institution under the charge of Mr. Schumaker, was placed temporarily in charge of Dr. H. C. Yarrow, of the Survey, for the purpose of making collections in ethnology upon the southwest coast of California, near Santa Barbara. The party from the Smithsonian Institution have carried on their labors upon the island southwest and adjacent to the coast at this point. The results of their labors already transmitted to Washington show that they were well bestowed; and without doubt the collections, when thoroughly worked up and reported upon, as they soon will be by Professor F. W. Putnam, curator of the Peabody Museum of Archæology of Harvard College, will show much information of value in determining the antecedents and presumable actual condition of the aboriginal tribes inhabiting this quarter at the time of interment of the individual bodies and specimens, and possibly their connection or want of connection with the present aboriginal races.

The Colorado Section was composed of three main parties, commanded respectively by Lieutenant W. L. Marshall, Corps of Engineers, Lieutenant W. L. Carpenter, 9th Infantry, and Lieutenant C. C. Morrison, 6th Cavalry. Their field duties covered parts of Southern and Southwestern Colorado, Central and Western New Mexico, from the Rio Pecos to the western boundary of this territory. The character of the geographical work has been advanced to such a degree that a complete geodetic connection is made to all parts of the area covered, each being taken from the crests of the several conspicuous mountain ranges that exist in this portion of the United States territory; the main triangulation being connected with measured and developed bases at the main astronomical points determined by parties of the survey in advance. Professor Jules Marcou, a veteran in geology, was a member of one of the parties of the California Section, and visited fields novel to him in the year 1854, when a member of Lieutenant Whipple's Pacific Railroad Survey party along the thirty-fifth parallel, bringing to his service the accumulated experience of geological investigations made by himself and others extending over an interval of nearly twenty-five years.

The subjects of Geology, Paleontology, and other branches of Natural History were made part of the season's work, as usual; and the advance therein, as well as in others, will appear in the regular reports submitted to the government from time to time. Dr. Oscar Loew, a member of the expedition for the third year, was engaged with the party upon the Colorado River in prosecuting, as usual, studies in geology and mineralogy; and it is hoped that the analyses to be made by him of the waters of the Colorado River, and of various soils and mineral substances, will add no little scope to the results of the season. The usual number of topographers, meteorological observers, etc., have been attached to the several parties.

The fact that this Survey is so far advanced in the improvement of its methods, and in the use of instruments specially fitted for mountain geodetic work, should appear as a gratification to all, since each and every person is or ought to be interested in the acquisition of exact geographical information; and that the government shall from time to time in so satisfactory a manner advance to a state of perfection the geographical works inaugurated under its charge, is evidence in the direction of the establishment of a great survey or surveys similar in plan, method, and execution, and perhaps more complete and original in many of their details than those so long prosecuted with so much profit and satisfaction by the great governments abroad.

One of the parties engaged in the Southern Sierras about the heads of King's and Kern Rivers were fortunate in ascending probably the highest measured altitude within the boundary of the United States, and determining its exact latitude, longitude, and altitude. This peak, known as Fisherman's Peak, had been ascended in 1872 by a party engaged in the pleasure of trout-fishing upon Kern River, and was by them discovered to be at least three hundred feet higher than any of the other prominent peaks, one of which had been named Mount Whitney by Clarence King, of the 40th parallel survey, and it is now determined to be approximately 14,800 feet in height. This peak was also ascended, subsequent to its being named Fisherman's Peak, by Mr. Clarence King, and his determination as to altitude, when made, should be a check upon the determination by parties of this season. A full description of this great monument of nature, something most difficult to be made, will be an individual evidence of one of the many discoveries made by the parties of this season.

Bases were measured at Los Angeles and Caliente, California. At the former place connection was made with the base of the United States Coast Survey, measured by the then Captain, now Brevet Major-general E. O. C. Ord, U. S. Army, and practically a connection was had with the geodetic stations of the United States Coast Survey, between latitudes approximately 34° and 35° north, and a complete system of triangles was carried eastward as far as approximately to the 120th meridian of longitude, in a three-tier belt.

Although the appropriation made by the last Congress was exceedingly meagre, still, principally through the assistance of the Quartermaster's Department, the greater percentage of the regular force was kept in the field, so the government was enabled still to avail itself of the skilled persons engaged in this work.

The publications of the Survey now advancing to completion consist of six quarto volumes; and two atlases—one topographical and one geological—are being rapidly advanced. Two volumes—those on geology and zoology—will be presented in January, 1876, and two others are in press, while the remaining two are being pushed with vigor. The sheets of the topographical atlas, now nearly completed, are twenty-four. Those of the geological atlas will number fourteen.

Lieutenant Wheeler, in his report submitted to the Chief of Engineers for the present year, recommends an additional volume upon the subject of Ethnology, Philology, and Ruins, based upon examinations made upon these subjects during several years, to be published as soon as provision is made therefor by Congress.

FRITSCHE'S TRAVELS IN CHINA.

Fritsche, who, since leaving the imperial observatory at Pulkova in 1866, has been very actively engaged in geographical, magnetic, and meteorological work, as director of the Russian observatory at Pekin, China, has recently published the results of observations during an extensive journey in Mongolia, Siberia, and Russia, undertaken in the summer and fall of 1873. His travels in Mongolia and Northern China carried him through countries as yet almost entirely unknown, the most important journey in this region having been that of the Archimandrite Palladius. This portion of Fritsche's exploration was performed by him on foot and horseback, although he states that his subsequent experience assured him that he could have made it, with safety to his instruments, in the Chinese two-wheeled wagon. The most important town on his route is Siwantsce, a large Chinese city, where is founded the central Belgian Catholic mission. The city is outside of—that is, north of—the great Chinese wall, and the missionary establishment is on the most extensive scale, with a fine church, and a school formed of poor Chinese children. The Christians living there, however, are not Mongolians, but the descendants of Christian Chinese who emigrated from China in order to escape the persecution of the Chinese authorities.

The contributions of Fritsche to the correct geography and hypsometry of the country traversed are numerous and reliable. One of the most interesting series of observations made by him consists in a large number of determinations of positions and altitudes of peaks belonging to a range of mountains which appears upon one or two old charts under the name of Petseha, but is not generally given upon our maps. The height of the principal peak seems to be about 1500 meters, instead of 14,000 feet, as was reported by the Archimandrite Palladius as having been given him by the Chinese authorities. No snow-clad mountains are known in the entire region. At two stations—Siwantsee and Chuschay—he was able to secure missionary observers, and promises from them of continuous meteorological observations. Magnetic observations were made by Fritsche throughout his entire expedition with a new and excellent instrument constructed by Brauer, according to the plan of Wild; and these afford him the basis for a short chapter on the secular variation of the declination, inclination, and intensity, as shown from the observations that have been made in China and Siberia since the journeys by Humboldt. The results in general confirm those given by him in an earlier work published some five years ago. The annual change in the magnetic intensity appears to have remained nearly constant in Western Siberia, but to have doubled in China and Eastern Siberia.

MAJOR POWELL'S FINAL REPORT.

In the summer of 1867 Professor J. W. Powell, of Bloomington, Illinois, undertook to make an examination of the fossil-bone region of the Bad Lands of the Niobrara and White River, north of the Platte, but, owing to threatened hostilities on the part of the Indians, the military authorities declined to permit him to run the risk of entering their country. He accordingly turned his attention to Colorado, and made some explorations in the direction of Grand River. In 1868 he again took the field, and proceeded first to the Middle Park, and thence down the Grand River to the head of Cedar Cañon, then across the Park Range by Gore's Pass, and by October was encamped on the White River, about one hundred and twenty miles above its mouth. Here he built cabins and established winter-quarters, and devoted the winter season of 1868–69 to excursions southward to the Grand, down the White to the Green River, northward to the Yampa, and around the Uinta Mountains.

Every season since then the Professor has been engaged in continuing his work, until what was commenced simply as an incidental summer's trip became an elaborate survey of the geography, geology, ethnography, and natural history of a vast extent of territory.

At the outset of his enterprise Professor Powell carried on his work without any aid from the general government beyond some facilities in the way of obtaining army rations. Subsequently, however, appropriations were made by Congress to a limited extent, and his survey was placed first under the War Department, then under that of the Interior, then under the Smithsonian Institution, and finally back again under the Interior Department, to which branch of the service it now belongs.

As in other government expeditions of later date, all branches of research have been well attended to. In the later years Professor Powell's labors have been carried on with the utmost precision, a base-line having been correctly measured, and a regular trigonometrical survey conducted. A large part of the cañon region of Colorado has been already mapped out by him, and its remarkable features well illustrated.

We have now to chronicle the appearance from the government press of the first volume of the final report of Professor Powell in the form of a handsomely printed quarto, with numerous illustrations. This volume is composed of three parts. First, the history of the exploration of the cañons of the Colorado, from Green River City to the cañon of Lodore, and from Echo Park to the mouth of the Little Colorado and the Grand Cañon of Colorado, with a special report by Professor Thompson, the topographer, who has been the companion and associate of Professor Powell during most of the period of the survey. The second part is upon the physical features of the valley of the Colorado. The third part, upon the zoology, consists of papers upon the genera *Geomys* and *Thomomys*—forms of rodent mammals very abundant in the region explored—and prepared by Dr. Elliott Coues.

The illustrations of the volume consist of two maps and eighty wood-cuts, of which about thirty represent geological sections, and about fifty landscape and other views. These latter are especially interesting from having been well engraved by H. H. Nichols, of Washington, from stereoscopic negatives printed directly on the wood, thus guaranteeing their fidelity, and proving that to be practicable which has been generally considered impossible.

REPORTS OF THE NORTHERN BOUNDARY SURVEYS.

It will be remembered that several years ago an international commission was appointed to mark the boundary between the United States and British America, from the Lake of the Woods to the summit of the Rocky Mountains, along the forty-ninth parallel of latitude. This survey from the east was made to meet the point at which the line started in 1857 from the Pacific Ocean had stopped in 1860. The superintendence of the second branch of the American line of the survey, as that of the first, was intrusted to Mr. Archibald Campbell, of Washington, with Major Twining, of the United States Engineers, as astronomer and surveyor, and Dr. Elliott Coues as geologist and naturalist, and the line was finished in 1874. Since then the American party has been engaged in preparing its report for publication.

The British branch of the survey has been not less industriously occupied, and has, indeed, anticipated its American colleagues in commencing the publication of the report, of which the first part—that on geology and the resources of the region of the forty-ninth parallel, by George M. Dawson, Esq.—is before us. Mr. Dawson is a son of the well-known Principal Dawson, of M'Gill College, Montreal, and inherits his father's tastes in the line of geology and paleontology.

The report, which is addressed to Major D. R. Cameron, the British commissioner, is quite comprehensive, and refers to the physical geography and general geology of the whole country, and the special geological structure of particular portions of it. The economical geology, which is represented mainly by the iron deposits and the coal, receives special attention. A considerable portion of the volume is devoted to the study of the glacial period and superficial deposits, as also to the capabilities of the region with reference to settlement. In the appendix is a list of fossil vertebrates and plants, the butterflies and orthoptera, the land and fresh-water mollusks, and the recent plants.

We hope soon to be able to chronicle the appearance of the American report, which it is understood will be fully equal in extent and thoroughness of execution to those of similar character recently published by the War and Interior departments.

THE SOURCE OF THE HUDSON.

Among the waters located on the new maps of Mr. Verplanck Colvin's Topographical Survey of the Adirondacks appears the little lake "Tear of the Clouds." In such a lake region as this, where every stream which does not flow directly from a pond, if further traced toward its origin, finally dwindles to a mere run without definite commencement, the last or uppermost pond upon it is generally accepted as the head and fountain of the river or stream. Were we to seek for any higher source than this, we must ascend from the rills, through the rain-drops, up to the clouds. If we take the highest permanent body of water of the river's source, we shall find the head of the Hudson in this little lakelet, "The Tear of the Clouds," or "Summit Water," high up on the side of Mount Marcy. The entire Adirondack region contributes more or less directly to the flow of the Hudson, and the opinion maintained by Mr. Colvin is quite plausible, viz., that a century hence, when the entire course of this river shall be occupied with villages and cities, it will be necessary to construct an aqueduct from the Adirondacks to New York, in order to supply that city and the interior towns with a continuous and generous supply of water whose purity can be relied on. It therefore seems important that even at the present time measures be taken to prevent the destruction of forests in this region, which may be accomplished by the state itself becoming proprietor of the greater portion of the territory, and setting it apart as a public park—as a summer reserve, in fact, for the feeding of the canal system of New York. We might then witness the astonishing spectacle of a wilderness agriculturally worthless becoming the arbiter of empire, and by its wonderful hydraulic facilities and fortunate location giving to the State of New York, to a considerable extent, the control of the commercial destinies of the great West, the Canadas, and New England.—*Colvin's Survey of the Adirondacks.*

CORRECTION OF LEVELS.

The officers of the Army Signal-office, as also of our public surveys, have daily need of accurate determinations of the altitudes of points in the interior of the country. To this end both the Coast Survey and the Smithsonian Institution have for many years been collecting the statistics of levelings made by railroad engineers, and all of these collections have been quadrupled in extent by the labors of the Army Signal-office. In addition to the extensive examinations given to this mass of material by the Weather Bureau, Mr. Gardner, the geographer to the Geological Survey of the Territories, under the Department of the Interior, has made an exhaustive analysis of the altitudes along certain lines of railroad, all leading to Denver, Colorado, his object being to determine the elevation of that point by as many independent lines of level as possible. In the course of his work very many illustrations show the great accuracy that can be attained by careful study, with good engineering instruments. He states, in effect, that of the innumerable discordances that occur, by far the greater portion are traced to errors of calculation, and not to instrumental defects or errors of observation. He establishes with great apparent probability some important changes in the accepted levels of points in this country. Thus the great lakes and surrounding country are found to be about nine feet, and St. Louis about twenty-three feet, higher than hitherto accepted. Kansas City and the surrounding country for many hundred miles south and west has heretofore been reported more than a hundred feet too low. Omaha is raised about thirty-one feet, and Indianapolis about one hundred. The range between the determinations of the elevations of various points is as follows: Lake Ontario, two determinations, a range of 3½ feet; Lake Erie, five determinations, a range of $2\frac{3}{10}$ feet; Lakes Michigan and Huron, nine determinations, a range of 5 feet; St. Louis, five determinations, a range of 7 feet; Omaha, five determinations, a range of 23 feet; Kansas City, four determinations, a range of 10 feet; Denver, three determinations, a range of 6 feet.—*Hayden's Annual Report for* 1873, p. 638.

HYPSOMETRY IN CALIFORNIA.

The use of the barometer in measuring altitudes in the interior of this continent has received excellent aid from the tables and investigations of Mr. Pettee, of Cambridge, Massachusetts, under the charge of Professor Whitney, state geologist of California. The work of Professor Whitney, besides containing an abstract of all the important publications relating to this subject, gives in detail the steps by which he has been able to compile an empirical table which, he says, may be used with advantage for California, and possibly for the whole of the Rocky Mountain region. The first requisite in the investigation being the accumulation of trustworthy observations, Professor Whitney found it necessary to establish stations in care of the telegraph operators on the line of the Central Pacific Railroad, supplying them with all auxiliary apparatus. These stations were maintained for three years, although with considerable breaks in the continuity of their record. The elevation of the highest point was seven thousand feet above the sea, and that of the lowest point only twenty or thirty. Among the conclusions that Professor Whitney draws from his observations, we mention that the resulting altitudes are always lower as computed from morning and night observations than at mid-day. They are also lower in winter than in summer, when the lines are based upon the mean of all the observations of any day. The results are found at some stations to approximate most closely to the truth in February, September, and October; at other stations in March, April, and September. The 7 A.M. and 9 P.M. observations give results which agree, in the main, with each other. In making use of the tables given by Professor Whitney, the most that can be hoped for is a better agreement among themselves of the altitudes computed from observations taken in different conditions of the atmosphere.—*Whitney's Contributions to Barometric Hypsometry*, p. 42.

THE STADIOMETER.

The stadiometer is the name given by Captain Bellomayer to an instrument invented by him, which is intended to give by one simple reading the length of any line whatever—straight, broken, or curved—as drawn on charts and plans executed on all kinds of scales. The principle of its construction is quite simple. A toothed steel wheel rolling along over the given line makes an endless screw move by means of a pinion. Upon the screw a slider, held in place by friction, is then forced to rise or fall. The graduations are marked upon two faces of the instrument, on the right and left of the slider. The instrument carries eight scales, corresponding to the scales of the French, Prussian, Belgian, Italian, and other national charts, together with the scale corresponding to the natural scale of our meter. Other scales which are less frequently used may be derived from those which are engraved on the instrument. In using the instrument it is held at right angles to the chart, the toothed wheel pressing against the surface of the latter. As the wheel is rolled along over a given line, the slider is, by means of the endless screw, pushed along the graduated scale of the instrument, and the quantity of its movement as shown thereon gives the exact line to be measured on the chart. The principle of the stadiometer has been for a long time known and used. For many years the French Dépôt of Charts and Plans has been accustomed to pay its engravers according to the total length of the curved lines which they trace, measuring these lengths by means of wheels rolling along over the lines; but the instrument devised by Captain Bellomayer replaces these elementary devices by a very portable, convenient, and precise instrument.—13 *B*, III., 203.

G. GENERAL NATURAL HISTORY AND ZOOLOGY.

ORIGIN OF ANIMAL FORMS.

Professor Cope in an essay published by the Hayden United States Geological Survey, dated February, 1874, discusses the origin of the great population of animal forms which previous explorations had disclosed in the lake deposits of Wyoming. His conclusion was that they had been derived by migration from the South, as geological investigations pointed to the earlier elevation of the land in that direction. During the summer of 1874, Professor Cope, as paleontologist of the United States Survey under Lieutenant Wheeler, sought for and discovered in New Mexico a great mass of lacustrine deposits, of somewhat earlier age than those of Wyoming, and containing the remains of a great number of animal species and genera, which so nearly resemble those of Wyoming as to leave no doubt that the latter were derived by descent and migration from New Mexico and the South.

In a memoir read before the Academy of Natural Sciences of Philadelphia at nearly the same time, the same writer states that the primitive type of the mammals with convoluted brains "must have been bunodonts with pentadactyle plantigrade feet;" that is, must have had tubercle-bearing grinders and five-toed feet, whose entire soles were applied to the ground in walking, and not merely the toes, as in most living animals. It was also stated that variations in the number and relations of the front teeth might be expected in such a hypothetical group of animals, which was named *Bunotheriidæ.* During the explorations in New Mexico the following season a remarkable genus was discovered, and afterward named *Calamodon.* Its jaws and teeth were obtained, and the latter had tubercle-bearing crowns. Subsequently Professor Marsh described more perfect specimens, which show that this animal was also five-toed (pentadactyle), and walked on its soles (plantigrade). With other similar genera he forms an order *Tillodontia,* and says that they are related to hoofed animals (*Ungulata*) and *Carnivora,* and that their brains were somewhat convoluted. This is a very full confirmation of the anticipation by inference above mentioned. It was then stated that the primitive Ungulate "can not be far removed from the primitive Carnivore and the primitive Quadrumane." Two other genera discovered by Professor Cope show that great variations in the number of the front teeth exist in these animals, some having one, and some two pairs of incisors, etc.

THE CELL-STRUCTURE OF ORGANIC TISSUES.

Professor Redfern, at the late meeting of the British Association, called attention to the changes that have taken place in the views of scientific men in regard to the cell-structure of organic tissues since the days of Schleiden and Schwann. At that time the separation of groups of cells by a basement membrane was considered to be an important physiological condition; such groups, retaining individuality, carry on their life, and even pass into such diseased conditions as cancer, without influencing or being influenced by neighboring structures. Now all is changed, and the idea of a cell as a vesicle has given place to that of a solid corpuscle. Graham has taught that all the tissues are permeable, and continually permeated by fluids carrying nutrient material; and we more lately learn that the living corpuscles can wander out of their positions of attachment, enter the blood current, and again pass from the blood-vessel through its soft and viscid wall. There indeed seems to be evidence that the finest filaments of nerves end in the living corpuscles or cells, especially in the olfactory and gustatory cells, and the skins of fishes. According to Professor Redfern, the statement of Pflüger that the nerves terminate in the cells of the salivary and pancreatic glands, although probable, has not yet been positively established.—15 *A*, *August* 29, 1874, 279.

RAPID DEVELOPMENT OF INTRODUCED ANIMALS AND PLANTS.

It is well known that certain plants, when grown in new countries, exhibit a remarkable development vastly exceeding that which takes place in their native soil. This is evidenced in the character of eastern vegetables when grown in California, of which such marvelous tales are sometimes related. The same thing appears to exist in a greater or less extent in the case of animals, especially in fishes, particularly where transported to countries in which that particular group was originally wanting.

Wonderful tales are told of the rapidity of growth of the German carp in California, to the effect that they will become as large in one year as they do in Germany in three or four, and be capable of reproduction in the same period. However this may be, we are assured that the success which has attended the introduction of the English trout into Australia has been quite remarkable. A recent writer states that in November, 1872, about 400 fry were turned out at Ballarat, having been hatched in the month of September previous. In January, 1875, or twenty-six months after being liberated and twenty-nine months after hatching, some of these fish were taken in a net, one of them, a female, weighing an ounce less than 10 pounds; two others turned the scales at 9¾ pounds, two at 9 pounds, and four or five others averaged 7½ pounds each; and the smallest fish taken weighed over 6 pounds, and all were in splendid condition.

A somewhat similar experience was had in the case of certain perch, the progenitors of which had been brought the year before from England. Three years previous a soda-water bottle, filled with eggs of perch, was placed in a lagoon at some distance from Ballarat. The fish hatched out, and quite lately several specimens weighing 5 pounds and upward have been taken.—19 *A*, *April* 24, 405.

INFLUENCE OF THE ROOTS OF LIVING VEGETABLES UPON PUTREFACTION.

Jeaunel states that the project for utilizing the waters of the sewers of Paris by allowing them to flow over 2000 hectares of cultivated fields, near Paris, has caused some apprehensions on the part of sanitarians. In reply, one may inquire why the neighboring island of Jennevillius, receiving, as it does, the enormous quantity of 240,000 cubic meters of putrid water, should not be a dangerous centre of infection, and menace the health of the populations of all the neighboring suburbs, and even of Paris, the northwest quarter of which is only two kilometers distant from the irrigated lands. This great question seems answered by experience. The inhabitants of the villages above quoted, the laborers who live upon the soil fertilized by the sewerage, are not subject to any of the maladies which it is customary to attribute to it, such as typhoid fever, malarial fevers, etc. This immunity doubtless results from the fact that the vegetables cultivated there are themselves powerful agents of purification. But science does not yet show precisely how they bring this about. The fact, however, that cemeteries, bogs, and marshes are made salubrious by vegetation is indisputable, being purely the result of experience. His own theory is that the roots of growing plants have the power of arresting the putrefaction of all organic matters held in suspension or in solution in the water; that these roots of living vegetables are sources of oxygen, since under their influence the bacteria and monads, as well as putrefying and fermenting matters, disappear, and are replaced by the infusoria which live in relatively wholesome water. Experience, in fact, directly confirms common opinion which attributes to vegetables the power of rendering wholesome the soils impregnated with putrefying animal matters.—*Bulletin Hebdomadaire*, XVI., 79.

COLLECTIONS OF FOSSILS FROM THE COAL-MEASURES OF OHIO.

Professor Newberry, director of the geological survey of Ohio, has lately made additional collections in the fossil-bearing coal-measures. Land vertebrate remains of that age within the limits of the United States have as yet been only found in Ohio, and the specimens are noted for their singularity and beauty. Thirty-three species of batrachia have been found, but no reptiles nor higher vertebrata. One of the novelties is a species of the genus *Ceraterpeton*—the first time a European genus of fossil batrachians has been detected in this country. This form is as large as a rat, and has a pair of stout horns on the back of its head, in the position and having much the form of those of the ox. The skull is sculptured by rows of small pits, separated by fine radiating ridges.

LIVING ANIMALS CORRESPONDING TO THOSE OF PREHISTORIC AGES.

The discovery of a living species of ganoid or dipnoan, fish of the triassic period, recently made in Australia, attracted much attention at the time. It is the *Ceratodus forsteri* of

Krefft. No other species was known which would connect the living and extinct ones during the great lapse of time between the mesozoic and existing ages. But recently Mr. Krefft has obtained a new *Ceratodus* from the same cave formations which contain the remains of the great extinct kangaroos and *Diprotodons*, which are late tertiary or post-pliocene. The species is called *C. palmeri*. Thus a beginning is made in tracing the line of succession similar to that recently developed in the case of the North American garfishes.

EOZOON, ITS ORGANIC CHARACTER.

The controversy as to the organic character of *Eozoon Canadense* still continues among geologists. It may be remembered that the organic character of this supposed fossil has been stoutly affirmed by Professors Dawson and Carpenter, and denied by Professor King and others. One of the latest sharers in the controversy is Mr. H. J. Carter, an eminent specialist in regard to the lower orders of animal life, and who expresses himself in the strongest terms on the opposite side. Dr. Carpenter, however, comes to the defense of his views by insisting that Mr. Carter has not made himself acquainted, in the slightest degree, with what has been written in support of the organic character of these objects, and that Professor Schultze, an equally eminent specialist, is satisfied that it belongs to the foraminifera.—12 *A*, *April* 23, 1874, 491.

ANTIQUITY OF THE CAVERNS AND CAVERN LIFE OF THE OHIO VALLEY.

Professor Shaler has published a memoir upon the "Antiquity of the Caverns and Cavern Life of the Ohio Valley," in which he endeavors to show the period at which the animal life, so characteristic of Western caverns, received its first expression. He sums up his researches in the following propositions: 1. The extensive development of caverns in the Ohio Valley is probably a comparatively recent phenomenon, not dating farther back than the latest tertiary period. 2. It is doubtful whether there has been any extensive development of cavern life in this region before these caverns of the subcarboniferous limestone began to be excavated. 3. The general character of this cavern life points to the conclusion that it has been derived from the present fauna. 4. The glacial period, though it did extend the ice-sheet over this cavern region, must have so profoundly affected the climatal conditions that the external life could not have held its place here in the shape we now find it, but must have been replaced by some arctic assemblage of species. Under the circumstances, it is reasonable to suppose that most if not all the species found in these caves have been introduced since the glacial period. 5. We are also warranted by the facts in supposing that there is a continued infusion of "new blood" from the outer species taking place, some of the forms showing the stages of a continual transition from the outer to the inner form.—*Memoirs, Bost. Nat. Hist. Soc.*

NEW MODE OF EMBALMING.

Madame Jaloureau has lately furnished what l'Abbé Moigno considers an important contribution to the question of the disposal of the bodies of the dead. This process consists essentially in the use of an impermeable coffin, together with certain substances which produce a rapid decomposition—not putrid, however—and which can not escape from its inclosure. The coffin, which is made of tough material, is thoroughly coated inside on all its joints with bitumen or asphalt, and covered on the exterior. The body itself is then brought in contact, prior to being sealed up, with phosphate of lime, which has the property, already referred to, of causing a rapid decomposition, but without any unpleasant odors. It is asserted that by this method coffins opened at the end of five years are absolutely free from any disagreeable smell. It is maintained that by following this process coffins may be piled one above another in limited inclosures, and without the danger of any unpleasant or noisome exhalation, and that interments can be made in vaults and tombs without necessitating the process of embalming.—3 *B, April* 1, 1875, 501.

THE INTESTINAL SECRETIONS.

Dr. Brunton has for some time past been prosecuting an inquiry into the intestinal secretion, with the special object of ascertaining, first, whether other neutral salts have a similar effect to that of sulphate of magnesia in promoting this secretion; second, whether any compound have the power of preventing such action; and, third, what are the nerves which regulate the intestinal secretions during life? In answer to the first, he has ascertained that several neutral salts possess the same power as sulphate of magnesia, but in a less marked degree. In reply to the second, he states that sulphate of atropia has such power over the secretion of the submaxillary glands, but that it has no effect in restraining the full action of magnesia in increasing the intestinal secretion. As to the nerves regulating the secretion, a negative result was obtained, he having ascertained that it was not the splanchnic nerves; what they really are Dr. Brunton hopes to learn in a future inquiry.—15 *A*, *August* 29, 1874, 274.

DISCOVERY OF ANIMAL REMAINS IN THE LIGNITE BEDS OF THE SASKATCHEWAN DISTRICT.

An important contribution to the question of the age of the so-called "transition" or "lignite" beds, which contain such a large proportion of the Rocky Mountain coal, has been made by George M. Dawson, the geologist of the British North American Boundary Commission. He has discovered a locality, rich in fossils, in beds of this age on the Milk River, in the Saskatchewan district. The remains presented include fishes, turtles, and numerous land saurians, but no mammals. The saurians belong to that strange group, the Dinosauria, which are not known to have existed later than the cretaceous period, and their presence determines the lignite beds to be cretaceous in that vicinity, as they have already been proved to be in Dakota, Wyoming, and Colorado. Several of the species are common to most or all of these places. There are also found in the Milk River locality remains of gar-fishes. These have been found also in the tertiary, and are yet living. Thus, although they are an ancient type, they connect the cretaceous and tertiary formations more closely than has been heretofore known.

THE FUNCTIONS OF CERTAIN CANALS IN THE EAR OF MAN AND THE MAMMALIA.

The most important paper in the department of anatomy and physiology presented at the last meeting of the British Association, in 1874, is said to have been that of Professor

Crum-Brown upon the function of the semicircular canals of the internal ear of man and the mammalia. From a critical study of various preparations made of fusible metals and otherwise, he concludes that these canals enable us to perceive rotation around axes at right angles to the plane of the canals. The fluid in the canals is set in motion by the rotation, and caused to impinge upon the delicate hairs in continuity with nerves, contained in the dilated portions of the canals; and according as the rotation is around one axis or another, the fluid of one or another of the three pairs of semicircular canals is set in motion, and we are enabled to estimate the direction of the rotation. A number of ingenious experiments were stated, in which the person to be experimented upon was seated on a rotating table; and precautions being used to exclude the use of other means of perceiving the amount and direction of rotation being called into play, the table was rotated, and the character of the sensorial impressions produced was noted. These varied with the position of the head, and the amount of the rotation, in such a way as to confirm Professor Crum-Brown's hypothesis that the semicircular canals are the organs whereby these motions are estimated.—15 *A*, *September* 5, 1874, 318.

RESTORING THE RED COLOR OF ALCOHOLIC PREPARATIONS.

M. Felix Plateau publishes a notice of a method of preserving or restoring the natural red color to muscular fibre kept in alcohol, in which he remarks that carbolic acid only preserves this red tint for a short time; besides which the odor is very disagreeable, and the preservation is not permanent unless in connection with continued cold.

Plateau's method consists in first soaking the specimen for some days, after being properly dissected, in commercial alcohol diluted with about half the volume of water, and then drying with a rag. Some small cups are to be prepared, containing respectively some carmine, in powder, mixed with a few drops of ammonia, some powdered chromate of lead (chrome yellow), and lampblack. By means of a small camel's-hair brush several layers of the solution of carmine, more or less diluted with ammonia, are applied to the muscles, after which a little chrome yellow or lampblack is to be added, so as to obtain, by this method of painting, the tint approaching as nearly as possible that of fresh muscular fibre. It is better to use but a small quantity of the liquid at one time than to put on several layers. When this is accomplished the entire preparation is immersed from five to ten minutes in a solution of alum, saturated in the cold. It is then rapidly washed in pure water, and finally placed permanently in alcohol.

The theory of the process is very simple, according to Plateau. By dissolving the carmine in ammonia, an ammoniacal solution, or carminic acid, is obtained; and after the painting of the muscle, the addition of alum has the effect of producing a gelatinous, uncolored precipitate of hydrate of ammonia, which is carried away by the excess of the liquid. Consequently, an insoluble carmine lac is formed, which, penetrating a certain depth into the flesh, forms a very solid dye. Specimens in the University of Ghent, prepared as long ago as 1872, still retain all their original beauty. It is not necessary that this process be practiced on fresh muscle. Any preparation, however old, can be restored in this way to the appearance of nature. It is of course optional with the experimenter to apply the color only to such particular muscles, in an anatomical preparation, as it is desired to trace out for demonstration.—*Bull. Roy. Acad. Sci., Belgium*, 1874, 476.

FAUNA OF THE MAMMOTH CAVE.

Interesting additions to our knowledge of the fauna of the Mammoth Cave have recently been made by Mr. F. W. Putnam, of Salem, who, as a special assistant on the Kentucky State Geological Survey, of which Professor N. S. Shaler is the director, had great facilities extended by the proprietors of the cave, and he made a most thorough examination of its fauna, especially in relation to the aquatic animals. Mr. Putnam passed ten days in the cave, and by various contrivances succeeded in obtaining large collections. He was particularly fortunate in catching five specimens of a fish of which only one small individual had heretofore been known, and that was obtained several years ago from a well in Lebanon, Tennessee. This fish, which Mr. Putnam had previously described from the Lebanon specimen under the name of *Chologaster agassizii*, is very different in its habits from the blind fishes of the cave and other subterranean streams, and is of a dark color. It lives principally on the bottom, and is exceedingly quick in its motions. It belongs to the same family as the two species of blind fishes found in the cave. He also obtained five specimens of four species of fishes that were in every respect identical with those of the Green River, showing that the river fish do at times enter the dark waters of the cave, and when once there apparently thrive as well as the regular inhabitants. A large number of the white blind fishes were also procured from the Mammoth Cave, and from other subterranean streams. In one stream the blind fishes were found in such a position as to show that they could go into daylight if they chose; while the fact of finding the *Chologaster* in the waters of the Mammoth Cave, where all is utter darkness, proves that animals with eyes flourish there, and is another evidence that color is not dependent on light. Mr. Putnam found the same array of facts in regard to the cray-fish of the cave, one species being white and blind, while another species had large black eyes, and was of various shades of a brown color. A number of living specimens of all of the above-mentioned inhabitants of the waters of the cave were successfully brought to Massachusetts after having been kept in daylight for several weeks, showing that all the blind cave animals *do not* die on being exposed to light, as has been stated.

THE AGENCY OF ATMOSPHERIC PRESSURE IN CAUSING THE UNION OF THE JOINTS OF THE HUMAN BODY.

The agency of atmospheric pressure in securing the union of the joints of the body has long been appreciated, although it has been thought that a puncture of the capsule connecting the joints, by thus admitting air, would materially affect this action. Professor Aeby, of Berne, however, has announced, as the result of a large number of experiments, that in the greater number and the most important of the joints of the human body the atmospheric pressure is fully adequate to retain the surfaces of the constituent bones in contact, even after the division of all the soft parts, including the capsule. This statement is true of the shoulder, elbow, and wrist, as well as of the hip, knee, and ankle joints, and the experiment succeeds in nearly every natural position of the joint, so that the extremity below any particular articulation can be made to swing within its normal limits of flexion, supported by the pressure of the air alone. Thus, as Professor Aeby expresses it, "When it is found that the arm will hang completely disarticulated in the shoulder-joint, the fore-arm in the elbow-joint, or the hand and fingers in their respective joints, no further proof is required that the ordinary teaching with regard to the relation of air-pressure to the joints is entirely erroneous." Dr. F. Schmid has also lately found by experiment that the atmospheric pressure which retains the surfaces of the hip-joint in contact is not only sufficient to support the lower extremity, unaided by muscles or ligaments, but even to carry an additional burden equal to a third part of the weight of the leg.—20 *A*, *May* 15, 1875, 529.

THE PHYSIOLOGICAL ACTION OF LIGHT.

In a memoir on the physiological action of light, by Professors Dewar and M'Kendrick, these authors have especially directed their attention to the effect produced on the retina and optic nerve. Their inquiry divided itself into two parts: first to ascertain the electro-motive force of the retina and the nerve; and, second, to observe whether this were altered in amount by the action of light. They conclude that the action of light is such as to alter the amount of the electromotive force to the extent of from three to seven per cent. of the total amount, so that a strong flash of light, lasting the fraction of a second, produces a marked effect. A lamp held at a distance of four or five feet, and, equally, the light of a small gas flame, after passing through a depth of twelve inches of a solution of salts of copper and potash, also produce sensible effects. When a diffuse light is allowed to fall on the eye of a frog, after the latter has arrived at a tolerably stable condition, the natural electro-motive power is in the first place increased, then diminished. The effects in question are caused by those rays of light that appear to be the least luminous—namely, the yellow and the green.—1 *A*, XXIX., 258.

ACID OF THE GASTRIC JUICE.

Dr. Roberteau has lately ascertained that the acidity of the gastric juice is due to hydrochloric acid, and not to lactic acid. This question has been the subject of much discussion between rival experimenters. According to Professor Wurtz, when lactic acid is met with in the stomach it is the result of an impaired digestion.—2 *A*, *February* 26, 1875, 154.

RESEARCHES ON THE SECRETION OF HONEY.

Dr. Reichenau has been engaged in an inquiry as to whether honey and other industrial products of the bees are obtained directly from the food of the insects, or are products elaborated by the organism. He has not completed his research; but as of three albuminoid, nitrogenous substances found in the honey, one, coagulable by heat, does not occur in the juice of the flowers, he infers that it is a true secretion by the bee, which becomes mixed with the nectar. Honey is, therefore, strictly a nitrogenous body, and not simply a carbo-hydrate. In purified beeswax nitrogen was found to the extent of 0.597 per cent.—15 *A*, *February* 6, 1875, 196.

ELECTRIC CURRENTS AND THE FERTILIZED EGGS OF FROGS.

M. Onimus, in a communication to the Biological Society of Paris, has made known the results of experiments on the effect of the opposite poles of the electric current in the germination of the fertilized eggs of the frog, from which it appears that those which were placed on the side of the negative pole are developed more speedily than those by the side of the positive pole. He also found that, by the use of electrodes other than platinum, metallic salts were deposited in the eggs.

LEUCITHINE AND CEREBRINE.

Gobley has published an account of a renewed examination of two bodies named leucithine and cerebrine, found together in the yolk of egg and in brain substance, leucithine being subsequently detected in human venous blood, eggs, milt of carp, and in milk. It appears that the substance obtained by Liebreich, of Berlin, in brain matter, containing phosphorus and nitrogen, and to which he gave the name of protagon, is really composed of these two substances; while the organic base found by treatment of this brain matter, and called by him neurine, is simply the product of the decomposition of leucithine, which when separated is a homogeneous, translucent, soft substance. When heated it swells, and, if the temperature be high enough, gives off ammoniacal vapors. It is insoluble in water, but dissolves in æther, chloroform, carbon-sulphide, and benzine. Cerebrine exists in brain matter, from which it is extracted by boiling alcohol. It is treated with æther to remove the fatty matter, and purified from leucithine and lime-phosphate by repeated solution in boiling alcohol. It is a solid, inodorous, colorless body, and is but little affected by æther.—21 *A*, *September*, 1874, 907.

GASES IN THE COAGULATION OF THE BLOOD.

As the result of some recent investigations by Messrs. Matthieu and Urbain upon the part which the gases play in the coagulation of blood, these gentlemen announce that carbonic acid is the agent of spontaneous coagulation; and that, during life, the obstacle to this coagulation resides in the blood corpuscles, which have as their special function the fixation not only of the oxygen, but also of the carbonic acid in the blood. As a result, the coagulating action of this gas can not be exerted in physiological conditions. The blood which returns from glandular organs, especially from the kidneys, is incoagulable, and contains very little carbonic acid. If the removal of carbonic acid from the blood be favored by simple exosmose, coagulation will not take place; yet, if it be placed in an atmosphere of carbonic acid, coagulation rapidly sets in. The clots, however, are softer than those which form in air, rendering it probable that oxygen influences their consistence. Lastly, certain neutral salts impede or prevent coagulation, but such salts fix a notable volume of carbonic acid, and thus withdraw it from the blood.—15 *A*, *October* 21, 1874, 491.

WIND PRESSURES IN THE HUMAN CHEST.

The new Physical Society of London seems to have extended its attention to the dynamics of physiological phenomena, Dr. Stone having recently read a paper before it on wind pressures in the human chest during performance on wind instruments. The author's object was to ascertain, first, what was the extreme height of a column of water which could be supported by the muscular act of expiration transmitted by the lips. This was found to be about six feet. Second, what was the actual pressure corresponding to the full production of a note on each of the principal wind instruments. It was found that with the majority of instruments the pressure required for the high notes is considerably greater than that required for the low notes, each instrument having a pressure ratio of its own. The clarionet is an exception to the rule.

THE DIAMETER OF THE RED GLOBULES OF BLOOD.

It has frequently been maintained by Dr. Woodward and others of the best microscopists that in general the microscope alone does not enable one to decide, by means of the dimensions of the red globules in blood, whether a blood stain belongs to the human subject or to some other of the mammalia. Additional light has been thrown upon this subject by the recent researches by Bershon and Perrier. They find that the red globules in the adult, when fresh, have a normal diameter of 0.0083 millimeter. In dried-up stains, however, the dimensions are as small as 0.0070 millimeter. In the new-born babe many globules are found as small as 0.0030, while many others, on the other hand, surpass the normal limit, and are as much as 0.0090. Thus out of 120 globules taken at chance from three subjects the dimensions were as follows:

	Millimeter.
2 globules	0.0031
2 "	0.0043
17 "	0.0050
11 "	0.0056
32 "	0.0062
6 "	0.0065
4 globules	0.0068
14 "	0.0075
5 "	0.0081
19 "	0.0087
2 "	0.0091
5 "	0.0093

We see from this the absurdity of pretending that in any case whatever of chemico-legal research the microscopist should pretend to decide as to the character of the blood-stains.—*Bulletin Hebdomadaire*, XVI., 44.

THE GASES OF THE BLOOD.

In a paper by Matthieu and Urbain upon the gases of the blood, it is stated that repeated bloodlettings in dogs caused an increased diminution of the percentage of oxygen contained in the arterial blood, and exercised but little influence upon the nitrogen and the carbonic acid. In the course of these experiments they ascertained that there was one half per cent. of hydrogen in venous blood, but none in arterial. Outside heat was found to have a great influence upon the oxygen of the arterial blood, its amount being much diminished after exposure to a high external temperature, although the number of respirations per minute is raised thereby. It would seem that increasing temperature decreases the endosmotic interchange of gases through the pulmonary mucous membrane, which has a greater influence in determining the amount of oxygen in arterial blood than the opposing fact of increased respiration. The lowering of the temperature was accompanied by an augmentation of carbonic acid. The amount of oxygen was dependent upon the activity of respiration, the increase of bodily temperature being at first followed by a decrease, and soon after it an increase of carbonic acid in the venous blood. Oxygenation takes place in the capillaries, and not in the larger vessels.

In death from cold there is a decrease in the consumption of oxygen, and but little difference in the composition of the arterial and venous blood. In death from heat there is, however, an enormous consumption of oxygen, and eventually the venous blood contains but little of the gas. The muscles become very acid, which was the cause of their speedy and pronounced post-mortem rigidity.—21 *A*, *August* 21, 1874, 809.

THE PIGMENT SCALES OF THE BLOOD.

Dr. J. G. Richardson makes an interesting suggestion as to the origin and nature of the so-called "pigment scales or flakes" of the blood. He says: "I call attention to an egregious error, by which several microscopists of acknowledged ability have been ensnared, namely, a belief in the importance of the 'pigment cells' or 'scales' described by Frerichs, of Berlin, as occurring in the blood; of similar bodies found by Drs. Meigs and Pepper, of this city, under like circumstances; and of the pigmentary particles, or celluloids, figured by Dr. William Roberts, of Manchester, England—all of which I assert to be simply and solely *accumulations of dirt* (especially the remains of red blood corpuscles) in the little excavations or slides in ordinary use."

Dr. Roberts observes: "I have been in the habit of observing these objects for many years, and have regarded them as derivations of hæmation; but how they come to assume their peculiar forms I am at a loss to conjecture." Dr. Richardson adds to this: "With him, I believe them to be derivatives of hæmation, but only by the *rubbing process* detailed above; and I trust that my 'conjecture' how these hæmative flakes 'come to assume their peculiar forms' may be satisfactory."

NEW SUBSTANCE IN URINE.

Messrs. Musculus and Mering announce that they have discovered a new substance in urine, after taking hydrate of chloral. This body, to which they give the name of urochloralic acid, is in the form of isolated, star-shaped crystals, soluble in alcohol, but almost insoluble in pure ether. The discoverers class this acid among the substances which, being introduced into the organism, combine chemically with some product of the system, and thus pass into the urine. Benzoic acid is the type of the group, which, in combining with glycocol, is eliminated in the form of hippuric acid.—12 *B*, *May* 15, 420.

IS SEX DISTINGUISHABLE IN EGG-SHELLS?

It has ever been a desideratum with country housewives and dealers in poultry to distinguish the sex which may result from given eggs, and to apportion accordingly in the nest. M. Genin has lately made a communication to the French Academy of Sciences, in which he claims ability to always separate them, and to have verified his hypothesis by the experience of several years. The eggs containing the germs of males, he says, have wrinkles at their smaller ends, while those containing females are smooth at the ends. We simply give this for what it is worth, and with a caution not to place implicit confidence in it. Indeed, the probability from analogy is against the claim. It will, however, do no harm to bear it in mind, and it will be worth while to make observations to verify or disprove it. The difficulty will consist in following up the egg through hatching out, and until the determination of the sex can be obtained. M. Genin does not tell us how to do this. The observations might be continued by any person in this way: The hatching of the wrinkled egg should be watched for at term time, and on liberation (which might be assisted by the experimenter) marked, for example, by the excision of the claws or tips of one of the toes (varying the toe cut with the individual), while those from smooth eggs could be allowed to remain unmutilated. If the coincidence between the character of the egg and the sex of the bird should then be confirmed invariably, as alleged, in say a hundred cases, the demonstration of the truth of the hypothesis would be complete, and entirely removed from the chance of irrelative or accidental coincidence. The egg cases should be kept for future reference and observation.

MENTAL ABILITY OF DIFFERENT RACES.

As the result of a laborious experimental investigation into the intellectual capacity and development of children of different races inhabiting the island of Jamaica, Mr. Houzeau concludes, first, that there is in each child a different degree of intellectual proficiency, though these individual differences are much less than might be anticipated; second, that an unequal rate or speed of improvement does not belong especially to any race; third, that the rate of improvement is due almost entirely to home influence, namely, to the relative elevation of the parental circle in which the children live. On the other hand, Mr. Lindsay concludes, as the result of his observations, that at or up to a certain age girls are as quick as, or quicker than, boys, at learning or repeating lessons, but that female superiority, so far as it exists, is usually confined to school life; second, that up to a certain point there is the closest parallelism between the mental endowments of the human child and sundry other animals; in some cases, even, the comparison is in favor of the animals; and yet that we have no reason for supposing that any of these will, at the best, ever attain to even the average of the intellectual and moral development of man.—12 *A*, X., 272.

ON THE EVAPORATION FROM THE HUMAN SKIN.

In order to determine how far the exterior circumstances, as temperature, moisture, the wind, etc., affect the quantity of water that passes from the human system in the form of perspiration, an investigation has been made by Erismann, under the superintendence of Voigt. By means of apparatus of his own construction he has been able to measure the amount of perspiration in different portions of the human body. He finds that the most important element in reference to the atmosphere is its relative humidity, an increase in the relative humidity corresponding to a decided diminution in the quantity of perspiration. Of less importance is the influence of the temperature. An increase of temperature acts not so much directly by increasing the capacity of the air for moisture as it does indirectly by first of all bringing about some changes in the skin, increasing the supply of water at the surface whence the evaporation takes place. The ventilation, or the wind, has also a very decided influence, the increase in ventilation corresponding to an increase in evaporation. There is considerable interest in his experiments on the influence of clothing upon perspiration, as showing that the clothed arm is subject to variations in the amount of perspiration, which are dependent upon the exterior influences of the air, as is the case with the naked arm. Clothing, in fact, does not diminish, but is rather favorable to the evaporation of water from the surface of the body.—19 *C*, VIII., 175.

VERTEBRATES FOUND IN THE DEPOSITS OF THE EOCENE LAKE IN NEW MEXICO.

Professor Cope, in a preliminary report to Lieutenant Wheeler, in charge of the United States Geographical Survey west of the one hundredth meridian, enumerates eighty-three species of the vertebrate animals as having been discovered by him in the deposits of the eocene lake that once covered the northern and western parts of New Mexico. Of these eight are fishes, twenty-four reptiles, and fifty-one mammals. Of the whole number, fifty-four species were introduced for the first time to the notice of scientists. This fauna is nearly related to that of the eocene of Wyoming in many respects, but differs in the distribution of many of the genera. Thus *Palæosyops agenus*, abundant in Wyoming, is not found in New Mexico, while *Bathmodon*, which does not occur in the Bridger beds of Wyoming, is the most abundant type in New Mexico, parts of over one hundred and fifty individuals belonging to seven species having been found by Professor Cope. Small tapiroid animals of the genus *Oro-*

hippus are abundant, and at least eleven species of lemurian monkeys were found. The carnivorous animals discovered number eleven species, some of which were as large as the jaguar, or larger. They are all quite distinct from living genera excepting one genus, which is related to the Asiatic civet. Some very small insectivora were also found, one of which is not larger than a small shrew. The waters of the lake abound in turtles, crocodiles, and gar-fishes.

A STRANGE RACE OF PEOPLE DISCOVERED IN INDIA.

The report of the Indian Trigonometrical Survey contains matter of exceptional ethnological interest in its account of an odd people living in the hill jungles of the western Ghats, to the southwest of the Polanei Hills. Stories had been heard of a strange dwarfish people in the southwestern corner of the Tinnevelly district, but it was not until recently that any thing definite was known about them, when Mr. Bond, a member of the survey, secured an interview with a man and woman. Of these the man was supposed by Mr. Bond to be twenty-five, and the woman eighteen years old. The man is four feet six inches high, twenty-six and a quarter inches round the chest, and eighteen and a half inches horizontally round the head over the eyebrows. He has a round head, coarse, black, woolly hair, and a dark-brown skin. The forehead is low and slightly retreating; the lower part of the face projects like the muzzle of a monkey; and the mouth, which is small and oval, with thick lips, protrudes about an inch beyond his nose. He has short bandy-legs, a comparatively long body, and arms that extend almost to his knees. The back, above the hips, is concave, making the buttocks appear to be much protruded. The hands and fingers are dumpy, and always contracted, so that they can not be made to stretch out quite straight and flat; the palms and fingers are covered with thick skin (more particularly the tips of the fingers), and the nails are small and imperfect. The feet are broad, and thick-skinned all over. The hairs of his mustache are of a grayish-white, scanty and coarse, like bristles, and he has no beard.

The woman is four feet six and a half inches high, twenty-seven inches round the chest above the breasts, and nineteen and a half horizontally round the head above the brows; the color of the skin is sallow, or of a nearly yellow tint; the hair is black, long, and straight, and the features well formed. There is no difference between her appearance and that of the women common to that part of the country. She is pleasant to look at, well developed, and modest. Their only dress is a loose cloth, and they eat flesh, but feed chiefly on roots and honey. They have no fixed dwelling-places, but sleep in any convenient spot, generally between two rocks, or in caves near which they happen to be benighted. They make a fire, and cook what they have collected during the day, and keep the fire burning all night for warmth, and to frighten away wild animals. They worship certain local divinities of the forest—Rákas, or Rákári, and Pé, after whom the hill is named Pé-malei. The woman cooks for and waits on the man, eating only after he is satisfied.—12 *A*, *May* 27, 1875, 73.

BOYD DAWKINS'S "CAVE HUNTING."

According to a review by the *Athenæum* of Boyd Dawkins's "Cave Hunting," the evidence of the cave deposits indicates the following facts, as far as our knowledge extends: "The climate and geography of Europe in ancient times were altogether different from those of the present day. We may infer, with a high degree of probability, that a paleolithic people migrated from the East into Europe along with the peculiar pleistocene fauna in the *preglacial* age, and disappeared with the same arctic mammalia, leaving behind them as their representatives the Esquimaux, who were cave-dwellers, and occupied themselves in hunting and fishing, and supporting life in a rigorous climate.

"An indefinite interval of time, which can not be measured by years, separated those paleolithic peoples from their successors of the prehistoric times. These latter, or *neolithic* people, arrived also from the East along with cereals and domestic animals. They were cave-dwellers, and also used caves as sepulchres, and we know more of them than of their forerunners. They were non-Aryan, swarthy (*melanochroi*), dolichocephalic, and short, and distinguished in many instances by *platycnemism* (a peculiar flattening of the shin). They were pastoral, herdsmen and farmers; and, when caves were not to be obtained, they buried their dead in chambered cairns. They disappeared, and left as their representatives the Basques, Berbers, and Kabyles.

"Another wave of migration swept over Europe from the East, this time Aryan, fair (*xanthochroi*), brochycephalic, tall, broad-shouldered Celts, who brought with them metallurgic skill, bronze and iron, and a higher stage of civilization. The ancient Basque continent was submerged by the Celtic populations advancing steadily westward, and certain parts of the non-Aryan peoples were left insulated, as the Ligurians, Sikani, Sardinians, etc. Similarly the Belgæ invaded the Celts, and the Germans in their turn pressed southward and westward on the Belgæ, driving away or absorbing the inhabitants of the regions they conquered."—15 *A*, *No.* 2458, *Dec.* 5, 1874.

HUMAN FIGURE ENGRAVED ON REINDEER HORN FROM THE CAVE OF LAROCHE-BERTHIER.

Among recent discoveries in the reindeer caves of France is that of a human figure engraved upon a reindeer horn, found in the cave of Laroche-Berthier, of apparently the same epoch as that of the Madeleine. This, although very rude in its execution, as figured by De Launay, is yet quite recognizable. It is not, however, of a character to give us any idea of the general appearance of the people of its day.—20 *B*, 1875, 192.

MR. GEORGE LATIMER'S ARCHÆOLOGICAL COLLECTION FROM PORTO RICO.

A very interesting and important addition to the ethnological branch of the National Museum at Washington has lately been made in the form of a large collection of objects of stone from Porto Rico. This was gathered during a period of many years by Mr. George Latimer, an American citizen residing in that place, who spared no pains nor expense to secure whatever could be obtained from the ancient graves in the island. The most noticeable features in the series consist of about fifty oval stone rings of much the size and shape of horse-collars, all variously carved and ornamented. There are also many statuettes, carved heads, triangular stones with faces of animals carved at either end, some pottery, and numerous axes and chisels—some of exquisite beauty, and polished to the highest degree. Many of them are of the green jade so much sought after by archæologists. Numerous applications have been made, and large sums of money offered by foreign societies for this collection; but Mr. Latimer declined to give any indication as to its proposed destination, and not until after his decease, in November last, was it ascertained that he had left it to the National Museum. The collection filled twenty-six boxes and barrels. It was carefully packed by the executors, and transmitted to Washington.

THE LOWEST OF KNOWN HUMAN FORMS.

The lowest of known human forms is represented by a lower jaw discovered several years ago in a cave near Naulette, Belgium. It possesses the massive form characteristic of monkeys, and, like those animals, has large canine teeth and little or no chin. There is, on the other hand, no interruption in the dental series, thus resembling man. It was for some time denied that this jaw is human, but it is now fully admitted to be such. Unfortunately the remainder of the skull is unknown. Subsequently a portion of a cranium, with other bones of man, were discovered in a volcanic deposit near Denise, near Puy-en-Velay, which were thought to indicate an inferior type, and one contemporary with the activity of the volcanoes of that region. When the French Scientific Congress met at Puy, these remains elicited much discussion, and their antiquity was denied. Specimens of different form and character were produced which were imbedded in the same material, but were apparently modern. Recently Dr. Sauvage has given the subject a thorough examination. He finds that the last-mentioned specimens are of doubtful authenticity, and may have been manufactured. The original ones he believes to have been buried in a volcanic eruption, and to represent a race contemporary with the activity of the volcanoes. The cranium is of the same low type as the race represented by the Neanderthal and Cannstatt skulls, having thick walls, a retreating forehead, and huge superciliary arches.

STONE KNIVES WITH HANDLES, FROM THE PAI-UTES.

Among objects of interest lately received at the National Museum in Washington are thirty-six stone knives, with handles, obtained by Major Powell from the Pai-Utes. The blades are oblong triangular and oblong tongue-shaped, acute, two or three inches in length, and so much resemble many of the so-called lance and arrow heads in collections that it becomes necessary to modify our views as to the latter articles. The handles are three to five inches long, and a notch half an inch deep at one end receives the stone, which is held in place by a tough pitch melted into the slit and around the joint, sinew being sometimes wrapped round in addition.

PREHISTORIC REMAINS FOUND NEAR SCHAFFHAUSEN.

A remarkable deposit of prehistoric remains has lately been found in the cavern of Thäingen, in the Canton of Schaffhausen, in Switzerland. Among the bones of animals met with were those of the European fox, and, what is very remarkable if true, those of the American fox (*Vulpes fulvus*), as also of the wolf, the dog, the brown bear, the wild-cat, the lion, the marmot, the European hare, the reindeer, the ibex, the chamois, the deer, the bison, the primitive ox, the pig, the horse, the elephant, the rhinoceros; and of birds, those of the ptarmigan.

There were also some very excellent carvings, upon bone, of the horse, representing a species little different from our own. Three distinct deposits were found in this cavern. The lower or gray layer contains the bones of the elephant, the hairy rhinoceros, the glutton, and the *Bos priscus*. The two superior layers consisted of angular fragments and rolled pebbles, with many bones. No remains of human industry are found in the middle and lowest layers.—1 *F*, *October* 15, 1874, 159.

ARCHÆOLOGY OF THE MAMMOTH CAVE.

A new phase in the archæology of the United States is shown by the researches of Mr. Putnam in the caves of Kentucky, as he has found that many of the caverns there were used for burial, as in Europe, and that others were used for habitations. Many relics and skeletons have been brought to light by his investigations, and further research, which will be carried on next year in connection with the geological survey of the state, will undoubtedly add much of importance to the archæology of our country. Enough evidence has already been obtained to prove that the caves were very extensively used by an early race of men, but the race to which the remains should be referred is not yet determined. In his investigations in the vicinity of a group of mounds in Monroe County, Kentucky, Mr. Putnam was also quite fortunate in finding a peculiar mode of burial that has not before been noticed, inasmuch as the bodies, in one case ten in number, were buried in a circular grave, made by placing erect slabs of limestone around a floor laid with thin stones. The bodies had all been placed in the grave at the same time, and evidently in a sitting posture, with their backs against the slabs. The skulls show a race remarkable for the shortness of their heads, and in one case at least exhibited a posterior flattening. The bones of the skeletons were quite thick and massive, and the shin-bones were remarkably flat.

EFFICIENCY OF ANCIENT WEAPONS.

An interesting experiment was recently made by the directors of the St. Germain Museum, in Paris. Certain implements of war, constructed from designs on Trajan's column, were tested, and it was found that the catapult threw arrows to a distance of 300 yards, and hit a mark regularly each time up to 180 yards. The same can be said of the onagea, which sent stones of one and a half pounds to a distance of 180 yards with astonishing precision. The initial velocity with which the stones were sent was calculated to be more than sixty yards per second.—12 *A*, X., 273.

THE SACRED FIRES OF THE PUEBLO INDIANS OF TAOS.

The *American Sportsman* of October 17 gives an interesting account of a visit to the Pueblo Indians of Taos, wherein the author describes one of their council chambers, or "estufas," as follows: "We were very curious to enter their council chambers, in which the same fire is kept constantly burning for Montezuma; but it was only after a great deal of persuasion, backed up by a promise of 'cuatros reales,' that the 'Capitas de la Guerra' consented to show us the one belonging to him by virtue of his office. We descended by a long ladder to the chamber, which is underground, and found ourselves in a bee-hive-shaped room with an arched ceiling.

All around the wall was a mud bench, and in the centre was a shallow pit containing ashes, with fire underneath. Just behind the fire-place was an altar, shaped like the upper part of a cross, and built of mud. The entrance to this curious room is defended by a sort of stockade, open at one side, the passage being just large enough to permit a person to pass. When councils are held, this post is occupied by a sentinel to prevent the entrance of the profane. Our friend, the war chief, said he let us in because we were Americans, but that no Mexican should ever enter. In all, we found five or six of these estufas in the village, belonging to the different head men, and used by them as council chambers."—*American Sportsman, October* 17, 1874.

ANCIENT MODES OF BURIAL AMONG THE INDIANS OF NORTH CAROLINA.

Mr. Wilcox communicates to the Academy of Natural Sciences of Philadelphia the account of an unusual mode of burial which was formerly practiced among the Indians of North Carolina. He states that in numerous instances burial-places have been discovered where the bodies had been laid with the face up, and covered with a coating of plastic clay about an inch thick. A pile of wood was then placed on top and fired, consuming the body and baking the clay, which retained the impression of the body. This was then lightly covered with earth.—*Pr. Acad. Nat. Sci., Philadelphia*, 1874, 165.

KITCHEN-MIDDING IN THE ISLAND OF ST. GEORGE, NEAR ATHENS.

Dr. Von Dücker has lately announced the occurrence of a kitchen-midding on the island of St. George, near Athens. This, however, is shown by Gaillardot to be the remains of an ancient manufactory of Tyrian dyes. Other shell heaps of a similar character have been found. One of them, located on the site of ancient Sidon, is a bank about four hundred feet in length, consisting entirely of the remains of *Murex trunculus*, and other species like it, furnishing a valuable dye. The *M. trunculus* is known to have yielded the most precious coloring matter used in the Tyrian dye, but it is suggested that the species was employed to produce the various other shades, such as red, yellow shot with black, etc.—15 *A, October* 31, 1875, 483.

DISCOVERY OF ANCIENT WELLS NEAR ASHILL, ENGLAND.

An extremely interesting archæological discovery has lately been made near Ashill, in England, of three wells on the site of an ancient Roman camp at Ovington, the mouths of which were covered with solid oaken frames. One of these was excavated to the depth of forty feet, and in it were found first a bronze fibula, some Samian ware, broken pottery, stones, and bones of cattle, with some other articles. Lower down the contents consisted of layers of urns, of which fifty were nearly perfect, and most of them of great beauty. They had been carefully let down into the hole, some of them inclosed in baskets; and the urns in each layer were arranged in different ways. At the lowest level several of the urns had still attached to them the remains of the cord with which they were let down into position. It is thought that these pits were formerly used for sepulchral purposes, and afterward hastily filled in with rubbish and covered up.—15 *A, October* 31, 1874, 483.

HYDE CLARK'S COMPARISON OF AMERICAN AND ACCADIAN LANGUAGES.

An elaborate paper was read before the Anthropological Institute, May 26, 1874, by Hyde Clark, and has since been published in a pamphlet, entitled "Researches in Prehistoric and Protohistoric Comparative Philology, Mythology, and Archæology, in Connection with the Origin of Culture in America, and the Accad or Sumerian Families." The design of the author is, in his own words, "to bring archaic philology into union with those nascent studies of anthropology, archæology, and mythology which have met with acceptance and popularity." He has elsewhere drawn attention to the similarity between the Agaid of the Nile and the Abkhass of the Caucasus with the Omagua and Guarani of Brazil, and in this treatise he enforces the unity of the race, and the history of migration, by reference to philological proofs. He first draws attention to the Pygmæan and other so-called prehistoric races of North and South America, of Africa, and of the islands of the Pacific Ocean, and then by parallels of culture he passes from tribes of the Old World to those of the New, somewhat similarly to the plan pursued by E. B. Tylor in tracing the growth of culture, and by Colonel Lane Fox in following the evolution of implements and weapons. He regards, for philological purposes, Egyptian, Sumero-Peruvian, Chinese, Thibetan, and Dravidian languages as protohistoric.

In the prehistoric period an idea was represented by three or four words, and a word stood for three or four ideas. We find that words are interchangeable, and that it is necessary to study their morphology for the purpose of understanding the equivalents or real connection of roots in various languages. In no department is this better illustrated than in animal names. Thus, among the Aryans, fire, dog, tiger, sun, star, and snake all conform, on the basis of their devouring every thing which they seize. Of this theory the author adduces numerous illustrations. In addition to resemblances of language between the continents, the author enforces his opinions by parallels of racial characters, by similar customs, by their works, and by their religious observances.

THE ANTIQUITY OF HUMAN REMAINS.

Mr. Evans, in the discussion of the alleged circumstances of the occurrence of human remains in deposits indicating the existence of man prior to the glacial period, is of the opinion that the human fibula found in the Victoria Cave, near Settle, England, is hardly enough to prove such antiquity, as this may possibly have been accidentally redeposited at a later period. Mr. Geikie, however, insists that the paleolithic deposits are in no way post-glacial, but are generally of preglacial and interglacial age. Mr. Evans is of the opinion that, although the evidence so far is not yet satisfactory, there is no reason why better may not be found, and he thinks that this is to be sought for in a warmer climate and among a more luxuriant vegetation.—13 *A*, *April* 24, 1875, 431.

THE SEMANGS, A PRIMITIVE RACE IN INDIA.

The Russian Geographical Society has received a letter from Mr. Miklucho-Maklay, from Singapore, dated April 13.

He reports that in the Semangs, a primitive and nomad race, gradually disappearing before Chinese and Malay civilization, he has proved the existence of a non-Malayan and a probably Papuan element. He is about returning to Russia for the purpose of publishing the results of his travels in New Guinea and other parts of the East Indies.—13 *A*, *June* 12, 1875, 607.

CRANIAL AMULETS.

Dr. Prunieres, in 1873, found in the dolmens of Marvejols (Lozère) some skulls, pierced, and in their cavities small rings of polished cranial bones. Since this discovery the attention of others has been drawn to the same subject. Baron Larrey, in a communication to the Academy of Medicine, describes trepanning among the Kabyles. General Faidherbe found two skulls in Roknia, Algiers, similarly treated. Mr. Squier presented to the Société d'Anthropologie a pierced skull from an ancient Peruvian huaca. M. Chil related at the Congress at Lille that he had found a perforated skull in the Canaries. In the *Gazette Hebd. de Médicine et de Chirurgie* for 1874 is an account of trepanning among the South Sea Islanders. The Greeks were familiar with the operation, and the word from which the name is derived, *τρεπω*, also describes the universal method of its performance. The motives assigned for this practice, which was performed upon infants and youth, upon the living and the dead, are various. That a blow from a stone battle-axe, or from a sling, pierced the skull, and deposited the round fragment in the cavity, is disproved by the fact that many of these wounds are healed, and the wound is unaccompanied by fracture. So we are to assign either a surgical or a religious reason; and inasmuch as religion and medicine go hand in hand among savage tribes, a mixed motive, or a purely religious one, seems to accord best with all the facts. A demon being the cause of disease, when the pain is in the head the Kabyles say they open the skull to let the disease out. The operation is not more painful than many of the initiatory rites of savages, only dangerous after violent contusion, and certainly not as fatal as the disemboweling practiced among the West Coast Africans. But the restriction of the operation to the young and to the dead points unmistakably to initiatory and funereal rites, and to the existence of ecclesiastical castes. The round fragments are all pierced in the centre, as though designed to be worn as amulets or relics. The singular habit of perforating, after death, the skull of one who had been trepanned while living, and of placing the bone rings in the skull of the dead, says M. Bertillon, points to their belief in the immortality of the soul, and the desire to furnish the subject with a whole cranium in the habitations of the blessed.—20 *B*, 1874, 383–396, and 13 *B*, *April* 10, 1875.

ORIGIN AND TRUE CHARACTER OF CERTAIN STONE WEAPONS.

In the Turkish collection of geological specimens and petrifactions at the Vienna Exhibition there were certain sharp objects, made of flint, about six inches long, one inch broad, and one fourth of an inch thick, which were, invariably, at once pronounced to be flint knives of the stone age by those who had made a study of such objects. As explained by Dr. Hammerschmidt, however, they proved to be modern articles, employed by the million, where wheat is grown, in Roumelia, Anatolia, Syria, etc., by the peasantry in the manufacture of a kind of thrashing-machine, in the form of sleds armed with these knives, which are drawn over the grain by oxen or men. They are very similar to the machines employed by the Romans, which were doubtless carried in all directions by their colonists.—7 *C*, IX., 1874, 568.

CRANIA-ETHNICA.—THE CRO-MAGNON RACE.

Messrs. Quatrefages and Hamy have published the second livraison of their great work upon the human crania, entitled *Crania-Ethnica.* The first part was devoted to a group to which they applied the names of the Canstatt races, and embracing such unusual forms as the Neanderthal, Nagykap, and other historic skulls. The present is devoted to what they call the race of the Cro-Magnon, in which they include human crania from the Madelaine, Laugerie-Basse, Bruniquel, Soloutre, etc. As in the Canstatt race, the authors consider the Cro-Magnon race as having continued in existence from the period when they were first found to the present time, being represented now by a few individuals, especially in Africa. The megalithic tombs of Roknia contain a large number of skulls similar to the Cro-Magnon, and the type is seen among the Kabyles and the Guanches of Teneriffe.—3 *B*, *April* 2, 1874, 663.

EVOLUTION OF THE HOG.

The predecessors or ancestors of the hog, Babirussa, and of similar existing animals, are being gradually brought to light by modern paleontological studies. One of these, nearest the domesticated form, has been found in the miocene of France, and is referred to the genus *Palæochœrus*. It is also related to the peccaries, which appear to have lived during the same early period in North America in considerable abundance. Their existence in South America at the present time is one of many indications that that region has not advanced in respect to its fauna as rapidly as our own and the old continents. Another miocene genus of hogs is the *Elotherium*, which has left remains in France and North America. The common species of the Nebraska beds is the *E. mortonii* of Leidy, which was as large as a pig. Its front teeth are much developed, at the expense of the hinder ones; and it had bony tuberosities on the under jaw, in the positions now supporting wattles in the hog. Professor Cope, of Hayden's United States Survey, discovered during the past season in Colorado much the largest species of *Elotherium* yet known. The skull was longer than that of the Indian rhinoceros, and the tuberosities of the lower jaw were greatly developed. The front pair formed divergent branches on the lower front of the chin, so that it appeared to bear a horn on each side, which the animal doubtless found useful in rooting in the earth. The species was semi-aquatic in its habits, like the hippopotamus and dinotherium; but while these are furnished with extraordinary developments of the lower incisor teeth for tearing up their food, the *Elotherium ramosum* is the only animal known which possessed horns in the same position and for the same purpose. A still older type of hogs—which may claim to be the predecessor in structure as well as in time of all known genera—is the *Achænodon*, Cope, from the eocene of Wyoming. The *A. insolens* was a powerful beast, larger than a bear, with a comparatively short head, and with the uninterrupted series of teeth which belongs to all the oldest forms of the mammals and to the higher quadrumana.

REPRESENTATIONS OF ANIMALS ON BONE AND HORN BY MEN OF THE REINDEER PERIOD.

Great interest is attached by archæologists to the representations of animals by men of the reindeer period of France, as executed upon bone plates of reindeer horn, etc., and the publication of the design representing unmistakably the hairy mammoth, or fossil elephant, not long since attracted universal attention. More recently other figures of the same character have been published, in an article by M. Louis Lartet upon some specimens belonging to the collection of his father, M. Edward Lartet. This consists of two sketches of the fossil elephant, made on either side of a polished plate of bone, showing unmistakably the trunk, tusks, and other characteristics; and as the two figures were in different attitudes, it would seem that they were probably representations of the same individual.

M. Lartet sums up all the figures of prehistoric carvings known to him of the fossil elephant, remarking that the first one discovered was on a plate of ivory taken from the cave of La Madelaine, in Perigord. A second was found at Laugerie-Basse, in Perigord, and a third specimen, from Bruniquel, is a little more doubtful as to its identification. M. Lartet in the same article reproduces an engraving of what he supposes to be a glutton or wolverine.—20 *B*, 1874, 33.

ORIGIN OF THE HORNS OF THE DEER.

The origin of the horns of the deer has recently been accounted for, especially in respect to the peculiar periodicity of their growth and subsequent shedding. It is well known that during the early winter male deer are hornless, but toward spring the tissues at certain points of the frontal bones thicken, and the enlarged arteries bring additional nutritive material, especially phosphate of lime, for the construction of horns. These grow so rapidly that horns weighing as much as seventy-two pounds have been produced in ten weeks. The lowest types of deer now living have unbranched horns, but shed them like the others. Some years ago there was discovered in the upper miocene beds of France an animal which might have been a deer but for the fact that it did not shed its horns when living. It was called *Dicroceras dichotomus.* Subsequently a similar species was obtained by Dr. Hayden in Nebraska, and was named *Antilope furcata.* A species of different character was discovered at the same time, and it had apparently shed its horn, and had a new one united to its base by a bur, as in the deer. It was described as *Cervus warrenii.* Professor Cope, of the Wheeler survey, rediscovered these species in New Mexico, along with two others not previously known, and referred them all to the genus *Dicroceras*, on account of the following observations: He noticed that in about half the individuals of a given species the horns are attached to the skull without interruption, as in an antelope, while in the others it had evidently been broken off and reunited. A mass of bony projections was developed at the point of union, producing a small bur, as in the living deer. It was evident that the cause of these appearances was an ordinary fracture and subsequent anchylosis, and it was supposed that the animals had broken off their horns in combats at the rutting season, in the spring of the year. It was inferred, further, that the excess of growth necessary to repair became, like many other animal phenomena, periodical, and that it was followed by feebleness and death of the horn. The latter was then cast off like any ordinary slough of dead bone.

NEW TERTIARY MAMMALS.

Professor Marsh, in the appendix to the *American Journal of Science*, presents a fourth notice of new tertiary mammals, among the most interesting of which are *Lemuravus distans* and *Laopithecus robustus*, two new genera and species of quadrumana. These were obtained on a recent expedition of the author to the Bad Lands of Nebraska. The last mentioned—a species of monkey—is represented by a single lower jaw, of about the size of that of a coati mundi.

Under the name of *Diceratherium*, Professor Marsh has described a distinct species of rhinoceros, provided with horns, the first of this character hitherto described in America. Here the horns were placed transversely, as in modern ruminants, and the remains indicate an animal of about two thirds the size of the Indian rhinoceros. Two other species of the genus, of less size, were also indicated.

The total number of new species of extinct mammals amounts to twelve, and of genera to eight.

PROFESSOR MARSH ON A NEW ORDER OF MAMMALS: TILLODONTIA.

Professor Marsh, on the 17th of February last, made a communication to the Connecticut Academy on a new order of eocene mammals, for which he proposes the name of *Tillodontia.* These are among the most remarkable vertebrates found in the American strata, and seem to combine several distinct groups, such as carnivores, ungulates, and rodents. In one genus, *Tillotherium*, the skull has the same general form as in the bears, and in its structure resembles that of the ungulates. In each jaw there is a pair of large, cutting incisors, covered with enamel, and growing from persistent pulps, as in rodents. The skeleton is most like that of the carnivores, especially the bears. The radius and ulna and the tibia and fibula are distinct. The other genera of this order have less distinctive characters. Some of the animals were as large as a tapir.

There appear to be two distinct families of the new order; one of them, which Professor Marsh calls *Tillotheridæ*, in which the large incisors grow from persistent pulps, while the molars have roots; and the *Stylinodontidæ*, in which the teeth are without roots.—4 *D*, *March*, 1875.

EOTHERIUM ÆGYPTIACUM, A NEW FOSSIL SIRENIAN.

Professor Owen has presented a communication to the Geological Society of London upon a peculiar form of "sea-cow," a sirenian mammal, named by him *Eotherium ægyptiacum*, which existed in the shallow waters from which the upper part of the nummulitic limestone of Egypt was deposited. The portion of the remains obtained shows that the animal had a relation to the recently extinct *Rhytina stelleri* and to the *Halitherium.*—13 *A*, *November* 21, 1874, 568.

SIR VICTOR BROOKE ON CERVUS BROWNII.

Sir Victor Brooke, a high authority in every thing relating to the *Cervidæ*, or the deer family, takes occasion to criticise the supposed species of fossil deer described by Mr. Boyd Dawkins under the name of *Cervus brownii.* This he shows, by perfectly satisfactory evidence, to be identical with the common *Cervus dama*, or fallow deer, of Europe. If this view be correct, then the fallow deer existed in England during the pleistocene period; but whether it became extinct in Northern Europe before the advent of prehistoric man, or whether it continued to exist in these islands even at the commencement of the Roman occupation, are questions yet to be solved.—12 *A*, *January* 14, 1875, 211.

A NEW KANGAROO FROM NEW GUINEA.

A new species of kangaroo, of the genus *Dorcopsis*, has lately been obtained from Southeastern New Guinea by Dr. Albertis, and described under the name of *Dorcopsis luctuosa*, this forming the second species of the genus now known from New Guinea. The island of Aru has long been known as possessing a species of true kangaroo, with a naked nose, described under the name of *Macropus brunii*. This is a remarkable fact in geographical distribution, as all the others known are natives of Australia and its more immediate surroundings.—15 *A*, *February* 6, 1875, 195.

DR. COUES ON THE MICE OF NORTH AMERICA.

Dr. Coues has published in the Proceedings of the Philadelphia Academy a synopsis of an elaborate work by him upon the mice of North America, based upon the many thousands of specimens in the Smithsonian Institution. In this he considerably reduces the alleged number of species, although describing some that he considers new. The genera retained by him for the American forms are *Neotoma*, *Sigmodon*, *Hesperomys*, *Ochetodon*, *Evotomys*, *Arvicola*, *Synaptomys*, *Myodes*, *Cuniculus*, and *Fiber*, some of them with several sub-genera. Twenty-eight species, some of which have numerous varieties, are recorded by Dr. Coues.—*Pr. Acad. Nat. Sci.*, *Philadelphia*, 1874, 173.

BARNACLES ON BIRDS.

Although barnacles attached to floating objects are known to be transported to great distances, thus far no case of transportation out of water has been recorded. During the recent cruise of the Italian frigate *Magenta*, however, several specimens of a stormy petrel, *Priofinus cinereus*, were shot in the southern portions of the Atlantic and Indian oceans, with numerous fragments of a species of barnacle attached to the abdominal feathers. It is supposable, therefore, that the larvæ attached themselves to these birds, which swim along the surface of the water, and dive after their food, instead of fixing themselves on inanimate objects, and that they are thus also, most probably, best preserved from the attacks of other marine animals. Upon closer investigation the very interesting and unexpected discovery was made by Professor Tozzetti that these barnacles are of a new genus, characterized by a provision for the retention of moisture, without which it would be impossible for them to survive so long a removal from the water.—19 *C, September* 12, 1874, 352.

FOOD OF THE MASTODON.

Dr. Hunt gives an account, in the Proceedings of the Boston Society of Natural History, of the contents of the stomach of a mastodon lately found in Wayland, New York. These consisted of remains of both cryptogams and flowering plants, exhibiting distinctly the vegetable characters. No sphagnum was found in the deposit. The evidence was that the animal had eaten his last meal from the tender mosses and boughs of the flowering plants growing on the banks of streams and margins of swamps, and that pines and cedars formed no part of his diet.—*Pr. Bost. Nat. Hist. Soc.*, XVII., 1, 92.

DISCOVERY IN NEWFOUNDLAND OF BONES OF THE GREAT AUK.

According to *Nature*, some bones of the great auk have lately been found in the Funk Islands, off the coast of Newfoundland, and carried to London. Unfortunately, however, they are not in a very good state of preservation. It was from this locality that two mummied auks were obtained some years ago, furnishing complete skeletons. One of these is in the Museum of Comparative Zoology at Cambridge, and the other, we believe, was sent to the British Museum in London.—12 *A, January* 24, 1875, 216.

HABITS OF KINGFISHERS.

Dr. C. C. Abbot, in *Nature*, combats Mr. Darwin's statement that the kingfishers, having caught a fish, "always beat it until it is killed," by the counter-statement that he had "never seen a kingfisher take its food otherwise than by swallowing it whole while yet upon the wing." He watched, in 1873, the belted kingfisher for eighty-three days, seeing it dive one hundred and sixty-six times, "and either every plunge was unsuccessful, or the bird swallowed, before alighting, every fish he had taken." In 1874 he saw them dive about four hundred times, and in eighty-six instances the bird beat the fish against the limb on which it stood before swallowing it.

THE FLIGHT OF BIRDS.

Monsieur Marey has made a series of observations which prove how important a part the onward movement of a bird plays in increasing the efficiency of each stroke of the wing; for, supposing that in its descent the wing did not continually come in contact with a fresh volume of air, it would act at a disadvantage, because the downward impulse, which at the commencement of each stroke it gives to the air below, would make that air, by so much, a less efficient resisting medium; while by continually coming in contact with a fresh body of air, the wing is always acting on it to the best advantage. For this reason, when a bird commences its flight it turns toward the wind, if possible, to make up for its lack of motion on starting.—12 *A*, IX., 1874, 390.

PROFESSOR ALFRED NEWTON ON THE MIGRATION OF BIRDS.

The desire to refute what he considers a very absurd theory in the *London Times* as to the migration of birds has induced Professor Alfred Newton, the well-known ornithologist, to address to *Nature* a communication on the subject of the migration of birds. He stigmatizes as absurd the idea, advanced by the writer in question, that birds, congregating on the coast, are seized with a sudden mania to fly upward, caused, as he supposes, by some atmospheric change coinciding with the warm south wind moving in a high stratum, into which the birds soar with an involuntary motion of their wings. This motion, involuntary like that of the heart, is continued for many hours, and the birds fly swiftly along until the paroxysm passes off, when they at once begin to descend, many of the feeble ones dropping into the sea.

It is the more easy to agree with Professor Newton in his criticism on this theory, as the phenomena of migration in North America show, not a paroxysmal impulse, but a long-continued movement, which lasts for weeks and even months, during which the birds make progress in definite lines, usually proceeding in the autumn to well-established wintering grounds, from which they return in the spring to almost the precise spot whence they at first started. In opposing the hypothesis of the *Times* correspondent Professor Newton at the same time confesses his ignorance in regard to the phenomenon, and remarks that the attention of observers should be directed to the following points:

First, the original cause or causes of migration. In some cases he thinks that scarcity of food is a sufficient and a most obvious cause. As food grows scarce toward the end of summer, in the most northern limits of the ranges of species, the individuals affected thereby seek it in other countries. In doing this they crowd out other individuals, and these, in turn, press upon still another zone, resulting in a stampede of the birds inhabiting a vast extent of country. He, however, does not find that the return movement is to be explained by any such hypothesis, since there is always an abundance of food in the winter quarters of the migrants, who leave for the North, where the ground may be still covered with snow, and where they are subjected to great inconvenience in their search for food. Next, the mode or modes of migration; not only whether different birds migrate in the same manner, but whether the same species maintain the same peculiarities throughout. The great question, however, is how birds find their way back to their old homes, returning after a journey of thousands of miles to the very spot where they were hatched, or where they had nested the previous season, and arriving at a given point on almost the same day in many successive years.

An hypothesis was presented some years ago by Middendorf, an eminent Russian naturalist, who believed that he had found in the magnetic currents circulating between the north and south poles of the earth the cause of the phenomena in question. This answers very well for the species which actually make use of a movement in the direction referred to, but fails to explain the case where, as in many countries, such migration is more nearly east and west than north and south.

NEW SPECIES OF A NEW GENUS OF SERPENT.

A new species of a new genus of serpents, collected by Lieutenant Wheeler's expedition in Arizona during the field season of 1874, has just been identified and named by Professor E. D. Cope. It is called *Monopoma rufipunctatum*. The rostral shield of this new genus resembles that of *Phimothyra*, and the lateral head shields those of *Cyclophis æstivus*. It is, however, more like *Eutænia* in general character. This is a very interesting discovery.

NEW SERPENT FROM FLORIDA.

Mr. S. W. Garman describes, in the Proceedings of the Boston Society of Natural History, a new American species of serpent from Florida under the name of *Helicops alleni*.—*Pr. Bost. Nat. Hist. Soc.*, XVII., 1, 92.

RESEMBLANCE OF EXTINCT TORTOISES TO LIVING ONES.

A remarkable announcement is made by Dr. Günther to the effect that the remains of extinct species of gigantic tortoises in the Mauritius and the island of Rodriguez have a very close affinity to the living species of the Gallapagos Archipelago, and differing from other tortoises of the same region in having a flat cranium and a truncated beak. According to Dr. Günther, the presence of these allied tortoises at points so remote from one another can be accounted for only by the belief that they are in each case indigenous.—4 *D, November*, 1874, 403.

THE HYBRIDIZATION OF SALAMANDERS.

Professor Gervais, of the Jardin des Plantes, instituted a number of experiments in the hybridization of various species of aquatic salamanders. He mingled males and females of the European Tritons of several species; but the eggs were not fecundated, and soon died. The eggs of a siredon, or undeveloped *Amblystoma*, from North America, were successfully impregnated by the males of the European *Triton cristatus*, and were deposited in large numbers. Some thirty young hatched from these, and became objects of much curiosity.

They were veritable hybrids, but presented the characters of the male *Triton* more distinctly than those of the female *Amblystoma.* In spite of the utmost care, they all perished as the time approached for undergoing their metamorphosis. In a subsequent year the experiment met with a similar result—the larvæ attained some size, but died before the absorption of the gills.

FOSSIL SALAMANDER: SALAMANDRELLA PETROLI.

Professor Gervais has described a fossil salamander from the permian formation, to which he gives the name of *Salamandrella petroli*, on account of its occurring in the petroleum beds of the Permian formation. It is much more nearly related to the true salamanders than to *Cheirotherium*, and constitutes a new genus.—13 *B*, *February* 20, 1875, 191.

THE BATRACHIA AND REPTILIA OF NORTH AMERICA.

The Smithsonian Institution has published a memoir on the geographical distribution of the Batrachia and Reptilia of North America, by Professor E. D. Cope, which is based on the large collections of the National Museum. In this work the primary divisions of the earth, as proposed by Sclater and Huxley, are redefined, and the mixture of South American families and genera in the North American fauna regarded as sufficient ground for separating it as a primary division from Europe-Asia. The subdivisions or provinces adopted are six, viz.: the Eastern, from the Plains to the Atlantic, as far south as the isothermal of 77°; second, the Austroriparian, extending from the Rio Grande to the Atlantic, south of the isothermal of 77°; third, the Central, extending from Texas and the Sierra Nevada to the eastern boundary of the Plains; fourth, the Sonoran, embracing New Mexico, Arizona, and a part of Nevada; fifth, the Pacific, all west of the Sierra Nevada; and, lastly, the Lower Californian, covering the peninsula of that name. Of these the central is the poorest in reptilian life; the two eastern provinces are distinguished for the abundance of the species of salamanders and tortoises; and the Sonoran and Pacific for the abundance of lizards. The Sonoran province is remarkably poor in salamanders and tortoises, while the Pacific district, with few tortoises, abounds in salamanders. The Austroriparian is the head-quarters of the toads and moccasins; the Sonoran is the centre of variation of toads, *Sceloporі*, horned lizards, and rattlesnakes. A great number of species is confined to this division. The snake-like batrachians belong exclusively to the Austroriparian district, the range of the genus *Siren* being co-extensive with its boundaries. A few Mexican genera extend east along the Gulf as far as Florida, and a few others of Sonoran character extend south into Mexico. The Lower California district is peculiar in its boæform serpents and large iguanas.

On the whole, the North American fauna is peculiar in its salamanders; Old World in its frogs and most of its turtles; and South American in most of its snakes and lizards, and some of its turtles.

REPORT OF THE OCCURRENCE OF LARGE COD-FISH OFF MAZATLAN.

Land and Water refers to the occurrence of some large cod-fish off Mazatlan, West Mexico, as having been caught in June, 1873, by officers of the British ship *Scylla*. The largest of these fish measured six feet in length and weighed 230 pounds, the others being of different magnitudes down to 85 pounds. This statement, however, requires confirmation. It is a question whether the fish were really cod, or some other fish of more tropical habit more or less resembling it.—2 *A*, *January* 2, 1875, 6.

GRAYLING IN THE AU SABLE RIVER, MICHIGAN.

The discovery of the grayling in the waters of the Au Sable River of Michigan, some years ago, has attracted much attention to this locality recently, and induced efforts to secure and multiply this fish in some more southern waters. Our knowledge of this species is due mainly to Mr. D. H. Fitzhugh, of Bay City; and by his invitation Mr. Fred Mather, the well-known fish-culturist, of Honeoye Falls, New York, visited the locality in his company on the 1st of April, 1874, but found that the eggs were not then ripe. On the 1st of May Seth Green went to the same region, at which time the fish had all spawned. He, however, dug out from the gravel about one hundred eggs, which he gave to Mr. Collins, of the Caledonia fish farm, to hatch out. These grew slowly at first, but at the end of six months were much larger than brook trout of the same age. On the 6th of April of the present year Mr. Mather revisited the Au Sable River, remaining there until the 12th. On the 8th he took spawn from two fish, and on the 9th and 10th from several more. He brought away 8000 spawn and 40 yearlings, the latter about five inches long. He also packed 4000 eggs for Mr. N. W. Clark, of Northville, Michigan, and gave him a considerable number of fish. These eggs, at the latest accounts, were thriving finely, and the embryo was expected to hatch out very soon. —*Live Stock Journal, May*, 1875, 150.

RESPIRATION OF THE LOACH.

M. Rougemont, in speaking of the European fresh-water fish known as the loach (*Cobitis fossilis*), says that when one of these fish is placed in ordinary water it respires by means of its gills, in a normal manner; but whenever the proportion of oxygen falls below a certain minimum, the fish rises to the surface and there takes in air, while bubbles charged with carbonic acid escape at the anal orifice. It therefore appears that the digestive tube itself performs the functions of respiration, and that it is in this organ that the blood finds the oxygen necessary to its purification. This tube is thus equivalent to an air-bladder, and when filled with air the fish rises easily to the surface. The so-called air-bladder of the fish is a small bony receptacle, situated under the first vertebra, and it is believed, in view of the small volume of air it is capable of containing, that it is not a real air-vessel, but is simply a resonant chamber communicating with the organ of hearing, properly so called.—1 *F*, *October* 15, 1874, 162.

MONOGRAPH ON THE ANGUILLIFORM FISH.

M. Dareste has communicated to the Academy of Sciences of Paris a monograph upon the anguilliform fish, and especially the generas *Anguilla*, *Conger*, *Myrus*, *Murænesox*, and *Nettastoma*, which he finds to possess comparatively few of the anomalies observed in the subjects of a previous memoir on the *Symbranchidæ*. In *Anguilla*, to which the common eel belongs, he finds evidence of the existence of only four species. One of these, the *A. vulgaris*, is found throughout the whole northern hemisphere, both in the New and the Old

World, exhibiting certain variations, it is true, but none of a specific value.

The other species, which he considers as belonging to this genus, are the *A. marmorata* and the *A. mowa* of the Indian seas, and the *A. megalostoma* of Oceanica.

Of the genus *Conger* he allows but four species; namely, the *C. vulgaris*, *balearicus*, *mystax*, and *acutidens*, the first two of which he regards as cosmopolite, and found simultaneously in almost all waters.

The variations in the external appearance of the true eel he thinks are produced in large measure by peculiarities of the ossification of the bones. In some the bones are in a cartilaginous or rachitic state, from which results a shortening of the jaws, or other deformations that produce a special impression upon the external appearance of the animal. Other variations are produced in both the conger and the true eel by the extent of albinism and melanism, special features appearing in each.—6 *B*, *November* 2, 1874, 988.

LARGEST PIKE EVER TAKEN IN ENGLAND.

Mr. Buckland, in *Land and Water*, acknowledges the receipt of what he considers to be the largest pike ever taken in England, weighing thirty-five pounds, and measuring three feet ten and a half inches in length. From the best evidence he could gather, this was one of the survivors of a small number of pike, weighing about one pound and a half each, which were placed in Ripley Lake some twelve years ago. The roe weighed three and a half pounds, and contained over 43,000 eggs.—2 *A*, *October* 24, 1874, 320.

HABITS OF EELS.

In view of the many points that still remain to be ascertained in regard to the life history of the eel, a recent communication published in *Les Mondes* may not be without its interest, however doubtful some of its statements may be. According to the writer, M. E. Noel, a certain fish-warden near Rouen, has observed that at about the end of September the large eels leave the sources of all the rivers and descend toward the salt water, at which time they are covered with a much thicker coat of muddy mucus than usual. They do not go down entirely to the sea, but stop in brackish water, where they can bury themselves a certain distance into the mud. There they knot themselves together, forming an enormous mass constantly in motion, the result of which is that the mucus becomes detached from them, and this, after a time, is found to swarm with myriads of little eels.—3 *B*, *May* 13, 1875, 79.

FOSSIL LEPIDOSTEUS.

Professor Gervais announces the discovery, among other fossils of the Paris Basin, of a species of true *Lepidosteus*—a genus of fishes now found living only in North America. He had previously made this suggestion, but somewhat doubtfully, and it is only quite recently that he has ascertained to his satisfaction that the species belonged where he had assigned it.—6 *B*, *October* 12, 1874, 846.

REPRODUCTIVE SEASON OF THE COD ON THE FAROE ISLANDS.

In a notice of the fisheries of the Faroe Islands, in the *Revue Maritime et Coloniale* for March, 1874, a fact is stated in regard to the natural history of the cod-fish which seems to require confirmation. According to this account, the cod-fish is, as may be supposed, the most important element in the fisheries, and those taken at the beginning of the year are said to be large and fat; and the time is also better fitted for drying them than at other seasons, as the air is then pure and cold. Their average weight when taken, after the head, entrails, and backbone are removed, is from twelve to thirty pounds. The cod is also very good during the months of March and April, but after this it becomes poor. It enters the harbors in May for the purpose of spawning, and is taken in great numbers in the summer. Cod, however, which remain in the open sea, on the Banks, are good throughout the year. The point of inquiry is as to the spawning of the cod in May, as Steenstrup has shown that on the coast of Norway they spawn in the winter season.—*Revue Maritime et Coloniale*, *March*, 1874, 762.

SOFTNESS OF BONES IN OLD CONGERS.

M. Camille Dareste (*Comptes Rendus Acad. Sc.*, Nov. 3, 1874) has confirmed in quite a number of individuals the fact that conger-eels not infrequently attain full size without a complete ossification of the bones, the skeleton remaining in a more or less cartilaginous state.

LEPTOCEPHALI ARE LARVAL FORMS OF CONGERS, ETC.

Some years ago Dr. Theodore Gill pointed out, what had not previously been even suspected, that the remarkable transparent and elongated ribbon-like fishes, attaining a length of several inches, and known as *Leptocephali*, were really immature or larval forms of congers and related types. This discovery, although received with some skepticism for a short time, has been since universally recognized by European and other naturalists. The observations of M. Dareste may be co-ordinated with the previous ones, and find an explanation for the *raison d'être* in occasional persistence to a still more advanced stage or throughout life of some characteristics which are normally in these forms protracted through a considerable term of the early life of the fish. While the incompleteness of ossification is persistent, however, the form and most other characteristics of the normal adult congers are attained, the only other known arrest of development affecting the teeth, which do not attain the customary size.

HAVE JELLY-FISHES A NERVOUS SYSTEM?

The umbrella-shaped jelly-like organisms known as jelly-fishes, or acalephs, which are almost always to be seen floating near the surface of the sea, are, next to the so-called Protozoans, the simplest forms of animal life, and the existence of a nervous system has been regarded as extremely problematical, and, indeed, denied by most authors. At the base of the tentacles, which originate at equal distances from the margins of the umbrella-like disk, or "rectocalyx," however, there are minute vesicular-like bodies (called marginal vesicles), which have been supposed by some zoologists (*e.g.*, Agassiz, M'Crady, and Fritz Müller) to be the rudiments of a nervous system. This supposition has received much support, recently, from vivisectional experiments made by Mr. George J. Romanes. Mr. Romanes's observations were made on the acaleph known as *Slabberia conica*, a species about as large as an acorn, and, as the specific name implies, having a conic rectocalyx, from whose margin four tentacles originate; at the bases of these tentacles are vesicles smaller than the dot which surmounts this *i*; small as these are, however, they appear to be so important to the animal economy that their excision paralyzes and renders inert the segment from which they are abstracted, and yet, although all that may be isolated from them is deprived of motility, the portions left connected with them preserve that function; thus, all but the margin may be cut away, and all such exsection will be rendered inactive, but the margin itself, retaining these vesicles, will still manifest, for an indefinite length of time, its contractile powers. Some of these facts (*e. g.*, the paralysis of the rectocalyx deprived of its margin) have been known before, but have been explained by the hypothesis that the severance of all the contractile fibres produces a kind of mechanical paralysis, analogous, for example, to disability to use the arms if all the muscles were divided. This explanation does not entirely account for all the manifestations exhibited in the experiments in question, and there is at least a strong probability that the minute dots referred to have a true nervous function.

SCUDDER ON THE BUTTERFLIES OF THE GENUS PAMPHILA.

A paper has just been published by Mr. Samuel H. Scudder, in the Memoirs of the Boston Natural History Society, on the butterflies of the genus *Pamphila*, in which, after a critical comparison of American and European forms, he comes to the conclusion that, after all, there is no difficulty in distinguishing the common species of Europe from its nearest American relatives. Of American forms he describes eight species, three of them in this work for the first time.

HABITS OF BEES, WASPS, AND ANTS.

Sir John Lubbock has recently presented to the Linnæan Society of London some very interesting notes on the habits of bees, wasps, and ants, drawn from his personal observation. The results seem to negative the idea popularly entertained that bees have the power of communicating intelligence from one to another; also that the working bees have any affection for one another, or for the queen bee independently of the utility of the latter for producing new broods. Bees have a decided taste in color, distinctly preferring blue to orange. Wasps are (Dr. Watts notwithstanding) of more industrious habits than bees, performing a larger number of journeys in the same time. Ants appear to possess a distinct power of communicating with one another, but different individuals vary greatly in this respect.

OCCURRENCE OF A COCHINEAL INSECT IN NEBRASKA.

Mr. Austin, in *Psyche*, calls attention to the occurrence of a cochineal insect, in great abundance, on several species of the cactus growing in the northwest of Nebraska and adjacent portions of Dakota. He can find no evidence that the Indians were acquainted with the existence of this substance in its practical applications as a paint; and, indeed, the fact of its occurrence there at all was unexpected by him, although he has since learned that it is not uncommon in Kansas and Southern California.—*Psyche*, *Dec.*, 1874, 30.

MINERAL SUBSTANCES IN THE ARTICULATA.

E. Häckel gives the result of a series of experiments upon the localization, or heaping up, so to speak, of various mineral substances in the articulata, and its physiological results, referring more particularly to the administration to various species, especially cockroaches and crabs, of a diet consisting of metallic arsenic and flour. After feeding with this substance for forty days the animals were dissected, and arsenic found in the cœca of the stomach, as also in the Malpighian tubes, in the latter the indication being most decided.—6 *B*, *August* 24, 1874, 513.

CAPTURE OF INSECTS BY "FLY-CATCHING" PLANTS.

Much attention has lately been attracted to the so-called fly-catching plants, and the object of the various provisions by which the capture of insects is rendered possible, whether, as in the Venus fly-trap (*Dionæa muscipula*), by the bringing together of two laminæ of a leaf, with a row of spines around the margin, or by attracting them into a cup-shaped receptacle, as in *Nepenthes* and *Sarracenia*, or by the presence of organs secreting a viscid juice, as in *Drosera*, or sundew, which holds an insect whenever it alights upon the surface. Professor Bailey, of Providence, has lately called attention to a similar function of the latter nature in the *Azalea viscosa*, or swamp honeysuckle, which has its corolla covered with innumerable clammy and glandulous hairs. In the bud these hairs appear to cover the whole surface of the flower, but when the corolla expands they seem to occupy the midrib of the petals as well as the tube of the corolla. These glandular hairs are efficacious fly-catchers, but what is their precise object, or the method of application, Professor Bailey is at present unable to indicate.—5 *D*, *September*, 1874, 517.

GIANT CUTTLE-FISH FOUND ON THE GRAND BANK, DECEMBER, 1874.

Some time since the discovery was announced by the Rev. Mr. Harvey, of St. Johns, Newfoundland, of a giant cuttlefish off the coast of that island. We now learn from him that a still larger one was cast ashore on the Grand Bank, near Fortune Bay, in December last. The larger arms measured twenty-six feet each, with a circumference of sixteen inches, the short arms being about one third that length with the same circumference. The total length of the body was fourteen feet. No portion was preserved excepting the beak and one sucker, which is an inch in diameter. The fishermen carried it off as food for their dogs. The specimens preserved will probably be sent to Professor Verrill, of Yale College, for comparison with what he has of the first one.

FAUNA OF THE CASPIAN.

Professor Oskar Grimm has lately published an account of the investigations made, under the direction of the Society of Natural History of St. Petersburg, upon the fauna of the Caspian Sea. The results of these had been extremely interesting and rich, no less than eighty new species having been discovered, and the total number known raised to 150.

According to Professor Grimm, the Caspian appears as a large, half-salt sea, possessing partly its own animal forms and partly such as occur in other seas, the former being descended from species still living or already extinct, or slightly changed from foreign related species in other waters. The species which occur in other seas are forms which possess great tenacity of life, as they still manage to sustain existence, their former associates of less hardiness having died out.

The faunal affinities of the Caspian are with the Sea of

Aral, the Black Sea, and the Northern Ocean, but those with the Arctic Ocean are more recent than with the Black Sea, in which the seal, the coregonus, and other species common to the Caspian and the Arctic Ocean do not exist. It has been inferred from the phenomena observed that in the tertiary period there was a large but closed fresh-water basin in Europe and Western Asia, which, by volcanic elevation of the earth's crust, was divided into several smaller basins, such as the Black Sea and Aral-Caspian. At that time the water of the Arctic Ocean broke into the Caspian, and having still a connection with the Black Sea, though a slight one, a few animals, and only a few, reached the sea from the latter.

The Caspian, however, according to Professor Grimm, not only received species from the Arctic Ocean, but has also furnished some to it, especially the sterlet (*Acipenser ruthenus*). As a general rule, in the Caspian Sea the abundance of individuals replaces the abundance of species, and many of the mollusks described by Eichwald as sub-fossil were found living, and not smaller than their extinct relatives. The deepest parts of the sea were inhabited most abundantly, and by quite different species from those at the depth of only a few fathoms. In Professor Grimm's opinion, the Oxus of the ancients at one period unquestionably flowed into the Caspian Sea.—18 *A*, *September* 3, 1875, 626.

GIGANTIC MARINE WORM.

Dr. Carl Möbius, an eminent German zoologist, of Kiel, has been engaged for some time in the exploration of the Mauritius and of the waters adjacent; and according to a letter received by Captain Nicholas Pike, of New York, from Edward Newton, Dr. Möbius has lately discovered a marine worm 300 yards in length!

DOMESTICATED ANIMALS AMONG THE ANCIENTS.

It is an interesting fact in the history of the domestication of animals among the ancients, that the Egyptians bred several species, and kept them in large numbers, which are not now employed in any part of the world. Among these are the Addax and Beisa antelopes, the gazelle, or Dorcas antelope, and the Kobe antelope. The evidence of this is found, together with much else connected with the history of the ancient Egyptians, in the pictures on the tombs, where flocks of these animals are represented with others receiving the attentions of the farmer and herdsman. From about 1800 years before the Christian era, however, these representations were fewer and fewer in number, and after that time their occurrence in relation to domestic animals seems to have ceased.

CHANGE OF COLOR IN THE CHAMELEON.

M. Paul Bert has exhibited, at a meeting of the Biological Society of Paris, a series of experiments on the coloration of the chameleons, bearing especially upon the changes of color produced if one or both eyes be extirpated. If a single eye be removed, the animal does not exhibit any change of color on the wounded side. If the light be brought to it, a very slow change of color takes place, and subsequently in that of the uninjured side. If both eyes be cut, a change of color on the two sides occurs under the influence of fierce excitements.

It has been previously ascertained by M. Bert that, on removing the right hemisphere of the brain of the chameleon, the animal only made use of the members of the left side, and after taking away the left hemisphere, then it could use the members of both sides.

This phenomenon seemed to indicate that to the chameleon is given in a measure a double being—that is to say, that the voluntary movements seem to recognize two centres, corresponding each to movement, coloration, and to sensations of the analogous side.—8 *B*, *September* 14, 168.

EXTINCT ANIMALS IN RODRIGUEZ.

It is well known that Rodriguez, the Mauritius, and other islands off the eastern coast of Africa, were at one time inhabited by various species of birds now entirely extinct, and known only by tradition, by the descriptions of several travelers, and by the occurrence of their bones in different localities.

The island of Rodriguez seems to have been much favored in this way, as mentioned by M. Leguat, who resided there from 1691 to 1693, and described species in his works that for a long time were supposed to be the figment of his own imagination, but which are now well established by osteological remains. The inquiry has been frequently made as to the precise period and the actual causes of this extinction, and Professor Alphonse Milne-Edwards has lately found a document which throws much light on the subject. This is a manuscript report in the Department of Marine, entitled "Relation de l'Isle Rodriguez," and is supposed to be of about the date of 1760.

According to this document, the birds continued quite abundant until about 1730, at which time, however, the settlement of the Isle of France and the Isle of Bourbon, together with the great number of vessels visiting the adjacent regions, made such depredations upon the living animals, especially the birds and tortoises, as soon to bring about their entire extinction. The birds were all restricted to narrow spaces, and being in large part unable to fly, fell victims to the weapons of the invaders. Indeed, so far as the tortoises were concerned, numerous vessels were employed exclusively in the business of collecting and shipping them.—1 *B*, *June* 20, 165.

FLIGHT OF BUTTERFLIES.

Mr. J. Matthew Jones gives an account of a very remarkable flight of small yellow butterflies, *Terias lisa*, of the family *Pieridæ*, which visited the Bermuda islands on the 1st of October, 1874. Their number was so great that their first appearance was that of a cloud coming in from the northwest, and when close to the land they separated into two columns, and dispersed east and west over the islands.

Mr. Jones does not consider that this was an intentional movement on the part of these butterflies, but that probably the individuals, while swarming at some point along the coast of the United States, were caught up in a cyclone or other storm, and carried out to sea to a great distance.

INTRODUCTION OF THE AMERICAN TURKEY.

The precise date at which the American turkey was introduced (probably from Mexico) into Europe has always been a matter of some uncertainty, its arrival in France having been ascribed to the action of the Jesuits. It took a conspicuous part in the nuptial feast of Charles IX., in 1570. A much earlier mention of this bird has, however, been found in a manuscript recently printed in France, where in Gouberville's diary, under date of December 27, 1555, he speaks of having had brought to him an Indian cock and hen. Probably the bird must have been known for some time, from this casual mention, as the same journal contains notices in detail of new forms of animal and vegetable life which had attracted his attention.—10 *B*, *June* 3, 60.

STONE ARROW IN A HUMAN TIBIA.

Baudrimont gives an account of a human tibia found in Aveyron which had a stone arrow-head inserted in it, and which had remained adherent, and had caused a considerable exostosis of the bone. But what is most remarkable is the fact that the arrow-head was inserted by its haft and not by its point, there being no indication of any perforation. For this reason Baudrimont is of the opinion that the wound had not been produced in actual warfare, but that in all probability this was a case of surgical manipulation with the object of producing some specific effect, either moral or physical, similar in this respect to the system of trepanning on the living subject, of which several very striking instances have been brought to the notice of archæologists.—20 *B*, 1875.

INFLUENCE OF TEMPERATURE ON NERVOUS SENSIBILITY.

At a recent meeting of the Russian Scientific Association, at Kasan, some results were given by Troitzky of observations made by himself to determine the velocity of propagation of the excitement produced in the nerves of frogs, by galvanic currents of various degrees of intensity and of various temperatures. He found that for feeble currents the maximum velocity of nervous sensations is between the temperatures +20° and +10° C. The velocity diminishes when the nerves are warmed to 30° or cooled to zero. In stronger electric currents the influence of temperature upon velocity diminishes, the velocity being affected more by the strength of the current than by the temperature. In the case of very strong currents the influence of temperature entirely disappears. The velocity of transmission in the nerves depends upon the strength of the excitement, increasing directly as the latter.—19 *C*, VII., 204.

ARTIFICIAL DEFORMATION OF THE TEETH.

At the meeting of the Anthropological Society of Göttingen, July 17, 1875, Dr. Von Jhering, after a brief mention of practices common among people widely separated, especially their barbarous toilet operations, gave a minute description of deformations of the teeth. These practices are of three kinds: 1. Coloring the teeth with red and black dyes (Borneo and Burma). 2. Knocking out one or more incisors of the upper or the under jaw by some tribes of Australia and of Central Africa. 3. Disfiguring the teeth without removing them. Many tribes of Central Africa chip the incisors with the chisel so as to make them pointed, sometimes in the centre, sometimes on one, sometimes on both sides. In the latter case they are bicuspidate. In the islands of the Malayan Archipelago the aborigines practice the filing down of their teeth, already discolored by the chewing of betel, in two typical fashions: 1. Removal of the enamel from the whole front surface of the crown by horizontal strokes of the file, and by smoothing down the edge—a species of mutilation characteristic of the Malays of the East Indian Archipelago. 2. A removal of the enamel in triangular pieces so as to leave the tooth pointed, and the remaining enamel rhomboidal in form. This is practiced in Java, Bali, Madura, and Celebes, and is not known elsewhere, so that Virchow, A. B. Meyer, and others believe it to be an exclusive mark of these islands. Dr. Von Jhering has observed this mark upon crania in various collections, but they have always proved to be from one of these four islands. We must therefore conclude that this species of mutilation had its origin there, although we have not the least suspicion to which people it belonged, or whether it was a mark of noble birth.

COMPARATIVELY SMALL BRAIN IN EXTINCT ANIMALS.

The study of the form of the brain in extinct animals is one of much interest, and has been prosecuted with considerable success lately. Some years ago Professor Lartet, of Paris, pointed out the small size of the brain in Eocene mammalia as compared with those of the present time. Professor Gervais has described the characters presented by the skull-cast in *Toxodon*—a remarkable and gigantic animal, whose remains have been found in the post-Tertiary beds of Buenos Ayres. His observations led him to coincide with the view of Owen—that *Toxodon* represents a distinct order of mammals. Professor Cope recently pointed out the small size of the brain in Symborodon, from the Miocene strata of the Plains, showing that the greater part of the skull was occupied by immense air-chambers. Professor Marsh, of Yale College, has since compared the brain cavities of various genera of the American Eocene and Pliocene periods with existing forms, and finds those of the first-named epoch to be exceedingly small, and that there is a steady increase in size in the subsequent periods. Thus the brain in the gigantic *Uintatherium*, of the Eocene, is little larger than that of some reptiles. In the lines of the rhinoceros, tapir, and horse a regular increase in size from such beginnings can be traced.

DIMORPHISM IN CERTAIN BUTTERFLIES.

Some species of butterflies of the well-known genus *Grapta* have been found by Mr. W. H. Edwards to be dimorphic forms. By the simple experiment of tying up a *Grapta dryas* in a bag at the end of a branch of its food-plant, it laid a batch of eggs from which resulted a large number of *G. comma* and six *G. dryas.* He now gives in the *Canadian Entomologist* the results of an experiment made with *Grapta comma,* the converse of that made in 1873 with *dryas.* On the 10th of May last he took a female, true *comma,* and tied it up to a branch of hop-vine. She laid in the bag some forty eggs, from which hatched thirty-nine caterpillars. Most of them in due time reached the chrysalis state; and between the 10th and 15th of June there emerged thirty-four butterflies, every one a *Dryas.*

ANOTHER LINK CONNECTING BIRDS AND REPTILES.

One of the most important papers read at the Hartford Meeting of the American Association for the Advancement of Science was presented by Professor E. S. Morse. In it he points out an additional link connecting the birds and reptiles. The astralagus (one of the bones of the ankle) co-ossifies early with the end of the tibia, and this "process," as it has been erroneously called, ascends as a spur from the upper side of the astralagus in front of the tibia. In certain extinct reptiles—like *Hypsilophodon*, *Lælaps*, and others—the ascending process of the astralagus shows itself as an avian character. A few years ago Professor Wyman discovered that this process had an independent centre of ossification, and therefore could not be a process of the bone. Mr. Morse had interpreted this bone as the "intermedium" of Gegenbaur. The intermedium is a tarsal bone, occupying a position between the astralagus and the calcaneum. In the saurians, turtles, and other reptiles this bone is well seen. In certain amphibians, as in the salamanders, the bone is long, wedge-shaped, and partially projects between the tibia and fibula. Mr. Morse has expressed his belief that the ascending process of the astralagus represented the intermedium of reptiles. He had published in the "Annals of the New York Lyceum of Natural History" a theoretic figure of the proper position of this bone in birds, comparing it with the intermedium of certain salamanders. He explained its position in front of the tibia as a supposed process of the astralagus, calling attention to the excessive tendency to anchylosis in birds. The widening of the tibia to include all the tarsals within its width necessarily brings the intermedium in front of the tibia, and, as it early unites with the astralagus, has naturally been mistaken. Mr. Morse has been able to confirm his opinion regarding the nature of this bone in studying the embryos of common tern at the Anderson School of Natural History, at Penikese Island. In the embryo bird the intermedium showed as a long oval bone, the astralagus and calcaneum passing up between the tibia and fibula, as seen in the lower reptiles.

In this connection it is interesting to observe that in the mammalia the intermedium does not occur, and Gegenbaur has expressed the opinion that the astralagus and intermedium united. These investigations might possibly go to confirm that opinion by the fact that in reptiles the intermedium is separate; in birds it is separate in the young bird, but connected with the astralagus in the adult state; while in mammals, if Gegenbaur is right, it is always so connected.

SEX IN THE EMBRYO.

Mr. E. Van Beneden publishes in Gervais's *Journal* a paper on the original distinction of the testicle and the ovary, in which he states that among the *Hydractinia* the eggs are developed exclusively at the expense of the epithelial cells of the endoderm, and remain up to the period of their maturity surrounded by the elements of the endoderm. On the other hand, the testicle and the spermatozoa are developed at the expense of the ectoderm, the organ resulting from a progressive transformation of the cellular fold, and originally formed by invagination.

He finds also that in the female spore-sacs there is the rudiment of a testicle organ, and in the male sacs a rudiment of the ovary. The spore-sacs, therefore, in his opinion are hermaphrodite. The endoderm and ectoderm have therefore opposite significations.—14 *B*, 1874, 450.

THE PALOLO WORM.

Among the most remarkable zoological phenomena of the Pacific Ocean may be mentioned the periodical annual occurrence at a regular date, in immense numbers, of a marine worm known as the palolo (*Palola viridis*), which appears in immense numbers in the vicinity of Samoa regularly at the time of the moon's last quarter in October or November. Its occurrence is eagerly looked for by the natives, who collect it in enormous amount and devour it greedily, both in a fresh state and also prepared in such a manner as to keep it for some time. From a paper by Mr. Whitmee, in the Proceedings of the Zoological Society of London for 1875, we learn that the two sexes are of different colors, and thus readily distinguishable, and that both males and females break up into a great number of small fragments, from which the eggs and the milt escape, so as to produce the necessary fertilization. Some idea of the abundance of this worm at the season in question may be gathered from the fact that the sea becomes quite of a milky appearance during this operation.—*Proc. Zool. Soc., London*, 1874.

OCCURRENCE OF MOA IN NEW ZEALAND.

Dr. Hector, at the recent meeting of the British Association, gave a very interesting account of the occurrence of moa bones in New Zealand, under this name including the various species of fossil giant birds, whether of the dinornis, harpagornis, or others. These remains are sometimes found on the surface, sometimes in caves; generally, however, in the open and low scrub, and not in the region occupied now or formerly by the primeval forests. In the subalpine portion of the south of New Zealand, covered only with a slight vegetation, large quantities of well-preserved moa remains have been recently found, associated with relics of the natives, proving still more conclusively than heretofore that they served as food to the inhabitants, and that they were a favorite object of pursuit.

The occurrence of large numbers of the bones together is thought to be due to the fact that the animals were crowded by the firing of the brush by the Maoris. They are also discovered in the swamps and peat bogs in almost all the valleys leading to the coast. One of these was at Glenmark, where the remains of a terrace, at a higher level, had been cut through by a stream, leaving a large deposit on the shoulders of the hills on both sides. Here great numbers of bones were found without any Maori implements, indicating as many as 1700 individuals that had either been carried down and smothered in the floods or had died naturally and been carried down by the water. Similar deposits occurred in caves and in bogs on the coast exposed below high-water mark, showing that there had been comparatively modern submersion; but there were no marine deposits above.

These bones were also found wherever the country was favorable for the Maori camps, on the sheltered grassy plots, or among the neighboring sand-hills. Here they were associated with the cooking hollows and with stone implements similar to those now used by the aborigines.

In caves the moa bones were found resting on the stalactitic shelves, and probably came there by falling through the upper chasms, or by being washed in by the water, as is now the case with the remains of the sheep. The earliest traces of the moa bones were at Poverty Bay, in the form of footmarks, in a soft pumice sandstone six or eight inches from the surface. Dr. Hector does not consider the moa to be of the tertiary age, the supposed bones from such deposits, in his opinion, belonging to a gigantic extinct penguin.

H. BOTANY.

RELATION BETWEEN THE MODERN AND TERTIARY FLORAS.

A communication was made to the Vienna Academy by Ettingshausen, embodying his extensive researches on tertiary plant-fossils and their study in connection with modern floras. Regarding the present vegetable world as the result of a former preparatory condition, he proceeds upon the fact that the modern floras were already prefigured in the tertiary flora, not confined, however, as at present, to different distinct regions; but that plants, at present denizens of widely different portions of the earth, then flourished in the same region. The state of preservation of the fossils of temperate and subtropical plants, often occurring even in the same piece of rock, renders this fact inexplicable on the hypothesis of the mingling of the floras of mountains and lowlands, and leaves only the conclusion that these plants flourished in immediate proximity. Hence the tertiary flora, in comparison with the modern, may be regarded as a kind of compounded primitive flora, which by resolving, as it were, into its elements, produced the present natural floras, each of which consists of a principal element, and to a greater or less degree of secondary elements; the term "element" being understood to include all geological plant-forms, the analogues of which at present belong exclusively to the region of one natural flora. The tertiary flora, therefore, as it involved all modern floras, was, so far, of the same character over the whole earth. In the present flora then, regarded as the more fully developed tertiary flora, there are of course plant-forms on which the impress of the original elements may be recognized, although somewhat altered. This is very evident in regard to the principal elements, but the effect of secondary elements in the development of modern plants can also be inferred from the relationship of many modern genera and species, as well as from their distribution; and components of the natural floras, which do not seem to conform to the character of the same, clearly betray their association with components of the secondary elements; and the more or less extensive groups of apparently exotic plants that are met with are only to be explained as the residue of secondary elements. Examples of the extent to which the composite character of the tertiary flora has still been retained are found in Japan, the southern portions of North America, and California, where plants related to those of almost all other regions occur. He sums up his conclusions as follows: 1. The natural floras of the world are allied to each other by the elements of the tertiary flora. 2. The character of a natural flora is determined by the predominant development of one floral element (the principal element). 3. Secondary elements have also affected the composition of modern floras, according to climatic conditions. The intermixture of members of the vegetable kingdom, apparently foreign to the character of the flora, produced in this way, sometimes appears only subordinate, but at others is of such an extent that it decidedly affects the character of the flora. 4. The species replacing each other in the regions of the different modern floras are corresponding members of similar elements.—19 *C, November* 14, 1874, 429.

CATALOGUE OF THE FLORA OF NEBRASKA.

A catalogue of the flora of Nebraska, by Professor Samuel Aughey, has been published by the University of Nebraska, with special reference to making exchanges of specimens. The general arrangement corresponds to that of Professor Gray, in his botanical works, and includes 2034 species as having been actually observed. Professor Aughey remarks that many of the native species along the eastern border of the state are rapidly disappearing, and others taking their place. Thus eight years ago the "silver-weed," *Potentilla anserina*, was common along the Missouri from Omaha to Dakota City, but is now rarely met with. He thinks, therefore, that the present condition of the flora of Nebraska should be put on record, so as to mark with greater accuracy the changes that may take place from year to year.

VEGETATION OF AMSTERDAM AND ST. PAUL'S ISLANDS.

It is a curious fact that the little island of Amsterdam, in the South Indian Ocean, is known to be covered with trees, while that of St. Paul's, only fifty miles to the south, is destitute of a shrub. Botanists have long been anxious to determine the character of the Amsterdam forest, but the difficulty of effecting a landing on the island has generally prevented the collection of specimens. In the last part of the journal of the Linnæan Society, Dr. Hooker announces that at length he has received the desired specimens, these having been collected by Commodore Goodenough, who states that they represent the only species of tree growing on the island. Dr. Hooker identifies this with the *Phylica arborea* of Thouars, a tree which, strangely enough, is found in the remote island of Tristan d'Acunha. It is a problem for those who study insular floras to suggest how the same plant can have established itself on these two little specks of land separated from each other by about five thousand miles of ocean.

LIST OF NORTH AMERICAN ALGÆ.

About twenty years ago the Smithsonian Institution published an elaborate work, by Professor William H. Harvey, of Dublin, upon the algæ or sea-weeds of North America, a subject which has always been of popular interest, as nearly all persons who visit the sea-shore are attracted by the beauty of the floating weeds, and are induced to make collections for preservation. The publication of this work gave a renewed impetus to the study, and at the present time there are many collections in the United States, both public and private, the determinations of all being based upon the work referred to. No systematic effort, however, has been made to bring the subject up to date, although Professor D. C. Eaton, of New Haven, and Professor W. G. Farlow, of Cambridge, have been engaged in investigations looking toward a revision of the group. Professor Farlow has, however, just published in the proceedings of the American Academy of Arts and Sciences of Boston a new list of the species, 430 in number, and embracing about 54 additions.—*Proc. Amer. Acad.*, 1875, 351.

BOTANY OF THE LIBYAN DESERT.

The Swedish botanist, Ascherson, has recently been exploring the flora of the Libyan Desert, having been attached for this purpose to the expedition of Rohlfs. Thirty-three species, belonging to 14 different families, were met with in the desert proper (*e. g.*, at least an hour's journey from any of the oases or wells), the best represented orders being the Cruciferæ, Zygophylleæ, Leguminosæ, Compositæ, Borraginace, Chenopodiaceæ, and Gramineæ. In the oases, 92 species were found in Farafreh, 189 in Dghakel, and 225 in Khargeh, besides a number of cultivated plants; but many of the former had evidently been accidentally introduced. Very few of the species were new, and these were nearly related to species already known.

MAXIMUM AND MINIMUM TEMPERATURE AT WHICH CERTAIN SEEDS WILL GERMINATE.

Hoberlandt has lately published a table showing the maximum and minimum temperature at which a large number of agricultural seeds will germinate. From this it appears that the minimum of the largest number, including wheat, barley, rye, oats, buckwheat, sugar beet, linseed, poppy, clover, pease, mustard, etc., is about 40.55° Fahr. The minimum for carrots, sunflower, sorghum, and maize lies between 40.55° Fahr. and 50.90° Fahr. For tobacco and the gourd it is between 50.90° Fahr. and 60.12° Fahr. For cucumber and melon it is between 60.12° Fahr. and 65.30° Fahr.—21 *A*, *Sept.*, 1874, 910.

ASSISTING THE GERMINATION OF SEEDS.

According to Böttger, a moderately concentrated solution of caustic soda or potash seems to promote the germination of seeds even more than ammonia, especially of coffee beans, which germinate with difficulty. After soaking a few hours in dilute potash solution, they often put forth snow-white radicles.—14 *C*, CCXIII., 1874, 444.

FOSSIL FLORA OF THE WESTERN TERRITORIES.

Under the title of "Contributions to the Fossil Flora of the Western Territories: Part I. The Cretaceous Flora, by Professor Lesquereux," Professor Hayden has published the sixth volume of the series of final reports of the United States Geological Survey of the Territories. The work is in quarto, and embraces one hundred and thirty-six pages and thirty plates. Very many new species are figured and described. The name of the author is, of course, a sufficient guarantee of the scientific value of this work, which covers all the known species of the Dakota group, and constitutes an important starting-point for similar monographs of other divisions of the fossil plants of America.

Professor Lesquereux gives an account of the circumstances under which this formation was discovered and explored by Dr. Hayden and others, and then considers the surface and stratigraphical distribution of the species. In accordance with Dr. Hayden's views, the author finds the group to be of marine origin, as shown by the occurrence of various species of marine mollusks.

Numerous important general considerations are presented by Professor Lesquereux in connection with his subject, and in the concluding part of the memoir he remarks that he is not prepared to commit himself in regard to the correlation of the flora of the Dakota group with that of subsequent geological epochs, and their identity, preferring to wait the gathering and examination of other series. He, however, states that this flora, without affinity with any preceding vegetable types, without relation to the flora of the lower tertiary of the United States, and with scarcely any forms referable to species known from coeval formations in Europe, presents, as a whole, a remarkable and, as yet, unexplained case of isolation.

ABSORPTION OF OXYGEN BY PLANTS IN THE DARK.

According to Dehérain, leaves kept in a confined atmosphere, in darkness, will absorb the whole of the oxygen, and still continue to give off carbonic acid, the resistance to asphyxia varying with the species. The rapidity of growth and energy of respiration of plants are both favored by obscure heat; and it is shown that the internal combustion, by the absorption of oxygen and emission of carbonic acid, is the origin of part of the heat necessary to the elaboration of new proximate principles in the plant.—21 *A*, *Sept.*, 1874, 910.

TRANSFER OF THE ALBUMINOIDS OF THE SEED INTO THE PLANTLET.

It is a familiar fact that germinating plants derive their nutrition from the reserve materials in the cotyledon, and that the insoluble starch of the latter is converted, in the process of germination, into soluble sugar, and, as such, transferred to the new plantlet. Some late German investigations have thrown light upon the method of transfer of the albuminoids of the seed into the different parts of the new plant during the process of germination. Asparagin, first discovered in asparagus, seems in general to perform this task, in giving up, in the first place, in the respiration of the plant, a certain amount of carbonic acid and water, and is afterward united in the new plant to corresponding amounts of carbon and hydrogen, to form albuminoid materials again.

EFFECT OF CHLOROFORM ON VEGETABLE INFUSIONS.

Barnes has made a communication to the Pharmaceutical Society of Great Britain upon the preservative effect of chloroform on vegetable infusions, in which he shows that of all substances applicable to the purpose of preparing unchanged infusions for medical purposes chloroform is among the most valuable. In one case four grammes of chloroform were added to four fluid ounces of mucilage of tragacanth, and at the expiration of a month the mass was found to be perfectly neutral, while another portion, not treated with the chloroform, had become strongly acid and unfit for use.

It is equally serviceable in preventing the souring of paste and gum-arabic, its special property seeming to depend upon the power possessed by chloroform to prevent alcoholic fermentation. When mixed with yeast, even in a warm place, fermentation and the accompanying development of alcohol is prevented.

Barnes also found that by adding twenty minims of chloroform to eight fluid ounces of fresh milk, the milk remained fresh after the lapse of five days, though kept in a warm place. If the milk thus treated be boiled just before using, all the chloroform will be driven off. The same application has also been used in the preservation of concentrated infusions of quassia, colombo, gentian, etc.—14 *A*, *March* 5, 1875, 441.

EFFECT OF SOLUTIONS ON A GROWING VINE.

Baudrimont has been continuing his experiments on the influence upon the branches of a growing vine of immersion in water containing various substances in solution, and has obtained some rather remarkable results, by various poisonous agencies, some appearing actually to increase the vigor of growth of the vine and prolong its existence, as in the case of chloride of potassium; while others cause the plant to wither, as in creosote and carbolic acid. Bromide and iodide of potassium seem to act in the same manner as chloride of potassium. Chloral hydrate exercises a very poisonous influence, destroying the branch vine in three days, the effect differing from that of carbolic acid. One of the most curious phenomena is that which is exhibited in the fall of the leaves. In some instances the petiole becomes detached at the point where it is inserted in the branch. This takes place with such substances as bi-chloride of mercury, and chloride, bromide, and iodide of potassium. In other cases it is the limb which separates from the extremity of the petiole. This occurs with ordinary water, and the nitrates of ammonia, potash, and soda. In one single instance both forms of observation have been observed under the influence of the same substance. Sometimes, again, the branch dies while the leaves continue to adhere to it. This is the case after the use of hydrocyanic acid and the essence of turpentine. Chloride of potassium acts as an invigorating and preserving agent, quite exceptional in its character. A current of ammonia allows the branch to preserve its freshness for eight days, after which it withers.—1 *B*, *Dec.* 20, 1874, 189.

HEAT AND VEGETATION.

In some remarks on the relation between heat and vegetation, which are translated by Firket from the work of Kabsch on the "Vegetation of the Earth," the latter states that the three fundamental laws of vegetation are as follows: First, for each plant there exists a maximum and a minimum temperature, between which this species is capable of normally exercising its vital functions; second, in the germination of grains, the opening of buds, the maturing of fruit, each has need of a certain average degree of temperature, which may be very different according to the species of plant; third, each species of vegetable, in order to go through the various phases of its existence, needs a certain sum total of heat, and it is only in the localities where this sum total is furnished every year, and where the conditions of humidity and the constitution of the soil are equally favorable, that the existence of the plant can be regarded as assured. Applying these principles to certain well-known plants, Kabsch finds for the grape-vine, for instance, that the limiting temperatures between which the vine can be cultivated naturally are minus 19° C. and plus 20° C. The average degree of temperature must be plus 8° C.; the sum total throughout the year must be 2900°.—*La Chaleur*, *Ghent*, 1873, 46.

HEAT AND VEGETATION.

Morren, of Liege, has presented his views on the relation of heat to vegetation, especially as to the dynamic influence of heat on the growth of plants. He says that we will elucidate this matter slowly, in proportion as physics and chemistry make progress in the revelation of the nature of bodies and forces. Heat has an influence upon the growth of plants, on the circulation of the sap, elaboration of the cells, the respiration, and many other phenomena. The relation of heat to the development of plants, and particularly the periodic phases of vegetation, are phenomena known through the epoch at which they manifest themselves, the mean dates of these manifestations, and the average deviations therefrom.

After giving an abstract of the results of the labors of Schubeler, Hofmann, Fritsch, Linnsser, and Kabsch, Professor Morren states that a problem of high importance, and one which has been, perhaps, too much neglected, is that of the relation between heat and the weight acquired by the plant under the action of the solar rays, and especially its relations to the quantity of carbon fixed in the organic matter, as far as we can at present estimate that. In a temperate climate a hectare of forest and prairie, or cultivated land, fixes in one year from 1500 to 6000 kilogrammes of carbon; and in order to accomplish this work vegetable organisms utilize between one and four thousandths of the heat which has been received by solar radiation upon the surface that they occupied. It is evident that such phenomena as take place periodically, viz., germination, leafing, etc., are acts of growth; such growth supposes movement; the fact of the movement necessitates consumption of force, which consumption is but a transformation of heat. If, to fix our ideas, we suppose an apple to fall from a tree, we have but to reflect upon the laws of force in order to see that the apple must have been previously carried up into the tree, for it evidently has not raised itself there. It is the power of the heat proceeding from the sun which has effected the development and growth of the tree. It is, therefore, practicable to determine the mechanical coefficient of growth, as Sausom has determined the mechanical coefficient of nourishment for foods. It is the property of vegetable organisms to utilize the heat received by them from any source, for the conversion of crude material into such forms as are needed by them for their own growth. In this process, however, force is neither created nor lost, although much of it is secreted within the body of the plant or mineral. Other things being equal, the quantity of carbon fixed in any plant varies with the average elevation of the height of its centre of gravity.—*Morren, on the Energy of Vegetation, Brussels,* 1873.

THE RESPIRATION OF LEAVES IN THE DARK.

An important paper by Dehérain and Moissan upon the respiration of leaves in the dark has lately been published in *Comptes Rendus.* Among the more important conclusions reached by the authors in their researches are: First, that the quantity of carbonic acid which is thrown off by leaves in the dark increases with the increase of temperature; second, that the quantity of carbonic acid thrown off is comparable to that yielded by the cold-blooded animals; third, that leaves kept in the dark absorb more oxygen than they throw off carbonic acid; fourth, that leaves continue to throw out carbonic acid in an atmosphere deprived of oxygen.

The authors present the following hypothesis upon the physiological uses of this internal combustion which takes place in the leaves, as the result of their numerous experiments. The immediate constituents which are necessary to the growth of the plants, and to the formation of new organs, are in part formed in the leaves. This growth is especially favored by warmth in the dark, as a principle well known to gardeners who cover plants, the development of which they wish to accelerate, under glass, in which case a part of the light necessary for the composition of the carbonic acid is reflected, but an elevated temperature is secured. This heat in the dark is especially favorable to an active respiration, as we find that the quantity of carbonic acid increases in proportion to the increase of temperature in the leaf, so that there seems to be a relation between the rapidity of growth and the energy of respiration.

This can easily be appreciated when we assume that a certain portion of the heat must enter into action in order to the formation of the immediate principles. The internal combustion, which is indicated by the absorption of oxygen and the throwing off of carbonic acid, is probably the source of the heat necessary for the formation of the new immediate constituents.—19 *C*, *June* 20, 1874, 235.

IODINE AND BROMINE IN FRESH-WATER PLANTS.

Zenger states that Petter detected iodine in the ash of the *Cladophora glomerata* in 1862, and that Jessler subsequently determined the amount to be 0.2343 grains in 9960 grains of the dried algæ. According to his own analyses, the ash of the plant amounts to 52.85 per cent., and 56,000 grains of ash contain 21.5 grains of iodine and 8.5 grains of bromine. The large amount of ash consists mainly of lime. He concludes from his own experience that iodine and bromine are present in much larger quantity than is suspected in fresh-water plants, and that they are also present in land plants, and suggests that fresh-water plants, by reason of their wide distribution, may become an important source of these elements. His most recent investigations of the aquatic plant *Lemna minor* show the presence of a large amount of iodine, and also of bromine.—18 *C*, *April* 14, 1875, 229.

ORGANIC SUBSTANCE IN THE PLANT.

A résumé of the past progress and present condition of our knowledge of the production of organic substance in the plant is given, in the Prussian *Landwirthschaftliche Jahrbücher*, by Professor Pfeffer, of the University at Bonn. Professor Pfeffer concludes that the production of organic substance from inorganic materials is dependent upon the action of chlorophyl, and requires in connection with the coloring matter of the latter nitrogenous protoplasm. The first product is generally starch, occasionally sugar, still less frequently fatty oil. The agency of light is requisite, the yellow rays being chiefly efficient. Many plants require but little light or but little warmth for assimilation. An increase of temperature above blood-heat is injurious or fatal, while an increase of light is only beneficial. The chief absorption of carbonic acid for assimilation is effected by the leaves, which give off oxygen in return. Another and more constant vital activity of the plant is slow combustion, with the giving off of carbonic acid; and this is noticeable only when the mass of assimilated carbonic acid sinks under that which is given off, as happens at night.

RESIN IN THE AGARIC.

It appears that the fungus known as the White Agaric (*Polyporus officinalis*) contains nearly sixty per cent. of resin, and it is suggested that this mushroom may advantageously be cultivated in large quantity on account of this ingredient.—18 *A*, *April* 23, 150.

OSTRUTHIN, A NEW VEGETABLE PRINCIPLE.

A new crystalline vegetable principle has been detected in the root of master-wort by Gorup-Besanez, to which he has given the name Ostruthin. It crystallizes in white needles or prisms, and contains no nitrogen.—21 *A*, *Sept.*, 1874, 907.

REVISION OF THE SUB-ORDER TULIPEÆ.

A revision of the sub-order *Tulipeæ*, by J. G. Baker, has recently appeared in the journal of the Linnæan Society of interest to American botanists. This group of six genera and one hundred and seventy-nine species is confined to the north temperate zone, having its largest development in Eastern Asia, but ranging largely on the one side to Europe and on the other to California and the Rocky Mountains. The tulip is the only genus not represented in America, the lily extending across the continent, and the fritillary stopping short at the Rocky Mountains. On the other hand, the calochortus, numbering twenty species or more, is limited to our more western territories. Of the half-dozen erythroniums, one is restricted to the Old World, the rest to the New. It is singular that a species in the smallest genus (*Lloydia serotina*) should be the one most widely distributed of all the lily tribe, and the only one that is really arctic or alpine.—*Jour. Linnæan Soc.*, XIV.

COPTINE.

A peculiar principle called coptine has been found by Gross in the *Coptis trifolia*, or golden-thread, of Europe and America. This is associated in the plant with berberine, but is distinguished by being colorless, and by yielding a crystalline precipitate with potassia-mercuric iodide.—21 *A*, *Sept.*, 1874, 912.

CHEMICAL COMPOSITION OF PLANTS.

Our knowledge of the chemical composition of plants used for food has been obtained for the most part from European analyses, which have, indeed, during the past two decades grown to be very numerous and complete. The most valuable tables of the composition of plants in use with us are of German origin. That these, in some cases at least, are not fully correct for American products is shown by some analyses lately made by Professor Storer. Samples of bog and meadow hay and other plants were found to contain only from 8 to 10 per cent. of moisture, and a sample of timothy hay yielded only 7.8 per cent. In the European analyses of different kinds of hay, 14 or 15 per cent. is generally given. Why hay in New England should contain only little over half as much water as in Europe is a matter worthy of investigation.

A BURIED FOREST IN ORWELL, ENGLAND.

Mr. J. E. Taylor, according to *Nature*, has discovered a buried forest in Orwell, England, represented by a layer of peat containing trunks, leaves, and fruit of the oak, elm, hazel, and fir, associated with the remains of mammoths. Mr. Taylor considers this forest to be contemporaneous with others along the coast which existed previous to the depression separating England from the Continent.—12 *A*, *Oct.* 29, 1874, 529.

DISTRIBUTION OF THE FERNS OF NORTH AMERICA.

Mr. John H. Redfield publishes in the *Bulletin* of the Torrey Botanical Club a paper upon the distribution of the ferns of North America, and arranges the species in six geographical divisions. The first of these he calls the *Cosmopolitan*, which embraces two species (*Pteris aquilina* and *Asplenium trichomanes*), distributed over the globe in both temperate and tropical regions. *Pteris aquilina* lives in sandy barrens, and is found every where from Lapland in the North to New Zealand and Tasmania in the South, in America reaching from Labrador to Alaska and the Isthmus of Panama.

Species of the second, or *Boreal* division, occupy the northern part of the United States, extending through Canada and British America, some of them to Labrador, Greenland, and Alaska, and represented also in the northern sections of the Old World. Of these there are twenty-seven species.

In this group we find an illustration of what has been noted by Professor Gray in regard to flowering plants, namely, a much closer relation between the species of Western America and Eastern Asia than between those of Eastern America and Western Europe. Thus the *Asplenium septentrionale* is widely distributed in the mountains and colder portions of Europe and Asia, but is only known in this country in the Rocky Mountains as far south as latitude 32°.

Pellœa gracilis, an American form, occurs in the Old World only in the Himalaya Mountains.

Third, the *Appalachian* division. The species occupy the mountainous and hilly regions east of the Mississippi, often to the coast, and northward to Canada, in some few instances occurring also in the Old World. The number under this head amounts to about thirty-eight.

Fourth, the *Pacific* division, which contains species extending to the western borders of the continent, from Alaska to California, in a few cases appearing also in the Rocky Mountain region. Here we have seventeen species.

Fifth, the *New Mexican* division. Of this some of the species occur in Mexico, and even in South America; a few also in California. There are twenty-seven species enumerated under this head.

The sixth, or the *Tropical* division, includes twenty-two species inhabiting the borders of the Gulf of Mexico, most of them extending to the West Indies and tropical America. Of these, one, *Trichomanes petersii*, is quite local, having been found only in Alabama and Florida.

Of 125 species enumerated, sixty-nine, or about fifty-five per cent., are found in the New World only, and of these sixty-nine about fifty-three, or over forty-two per cent. of the whole, are restricted to the limits above assigned. There remain seventy-two species which we share with other portions of the world. Of these forty are found in common with Europe, four of them not occurring elsewhere.

We have thirty species in common with the Himalayas of Northern India, of which two are not found elsewhere. With Northern or Eastern Asia we have thirty species in common, and, taking the whole extent of Northern and Eastern Asia, we have forty-six species in common out of the seventy-two, showing a very decided preponderance in Asiatic forms, as already referred to.—*Bull. Torrey Bot. Club, Jan.* 1, 1875.

THE BLADDERWORT A CARNIVOROUS PLANT.

Mrs. Mary Treat communicates to the New York *Tribune* of February 1 some original observations upon the bladderwort (*Utricularia*), and its functions as a carnivorous species, as in the case of *Sarracenia*, *Drosera*, etc. Bladderwort grows abundantly in shallow ponds and swamps throughout the Northern United States, and is characterized by the possession of numerous little bladders scattered among the leaves, which were supposed to be used in some way for floating the plant, especially during the flowering season.

Mrs. Treat, however, had her attention called in the first place to the fact that the bladder-bearing stems really sank lowest into the water, and the subsequent detection of minute microscopical animals in the interior induced her to examine the subject in reference to a possible animal diet. She has finally satisfied herself that the true function of these bladders is to entrap the various forms of animals, some of them larvæ, probably of dipterous insects and others, entomostraca, such as *Daphnia*, *Cyclops*, and *Cypris;* and that, once inside of the bladders, the latter constitute so many little stomachs for their convenient digestion. — *N. Y. Tribune, Feb.* 1, 1875.

NEW SPECIES OF GLAUCIUM.

In working over the refuse of the ancient silver-mines of Laurium, in Greece, for the purpose of extracting the remaining percentage of metal, a considerable amount of soil has been uncovered, in which has appeared over a tract of 50,000 square meters a luxuriant growth of *Glaucium*, which is characterized as a new species under the name of *G. serpieri*, and is unknown elsewhere at the present time. It would appear from the indications that the seeds of this plant must have remained alive during the interval of 1500 or 2000 years which have elapsed since the mines were last worked. —13 *A*, *March* 29, 1875, 295.

STIMULATING ACTION OF CAMPHOR ON PLANTS.

Dr. Vogel, of Munich, has repeated the experiments made by others on the stimulating action of camphor upon the growth of plants. He concludes that, except in a few cases, we possess in camphor a stimulant capable of greatly increasing the luxuriance and rapidity of the growth of plants. Thus, when branches of seringa in flower were introduced into camphorated water, the drooping of the plant was entirely overcome, some blossoms being even developed under these circumstances. The seeds of *Lepidium sativum*, after having been kept dry for three years, were watered with camphorated water, and germinated with remarkable quickness; while the seeds of *Raphanus sativus major*, which had been dried for five years, and had refused to germinate in the garden, when treated with camphorated water germinated in four days. Similar interesting results have been obtained with other seeds. Some experiments made with the essence of terebinthine have shown that, while like camphor favoring the germinating process, the former arrests the ulterior development of the plant.—*Bull. Hebd.*, XVI., 46.

DARWIN ON INSECTIVOROUS PLANTS.

Mr. Darwin's new work on insectivorous plants has been a great success, 2250 copies of the English edition having been sold in a very short time. The most interesting and novel point which he brings out is the existence in *Drosera*, *Dionæa*, and some other plants which come under this designation, of an actual digestive fluid, which in the case of *Drosera* becomes acid only when the secreting glands are excited by the presence of nitrogenous matter, a substance being formed apparently closely analogous to the pepsin contained in the gastric juice of animals. The excessively minute quantities of nitrogenous substance which cause inflection of a gland of *Drosera* are very astonishing—in the case of carbonate of ammonia about a twenty millionth of a grain.

INFLUENCE OF AMMONIA ON THE COLORS OF FLOWERS.

The Journal of the Central Horticultural Society of France gives some interesting details of the alterations which the natural colors of flowers are subjected to under the influence of ammonia. If we expose flowers originally of a violet hue to the fumes disengaged by a cigar, we see these flowers take a green tint more pronounced than was their proper color. This change is due to the ammonia in the tobacco smoke. Starting with this idea, the Italian Professor Gabben has made a series of experiments having in view the changes that ammonia brings about in the colors of different flowers. He simply made use of a plate containing a certain quantity of a solution of ammonia known commonly as volatile alkali. He shows that, under the influence of ammonia, blue, violet, and purple flowers become a beautiful green, red and carmine grow black, and white flowers turn yellow. The changes of color which are most singular are those shown by the flowers which have many different tints, out of which the red lines become green, the white yellow, etc. A remarkable example of this is seen in the fuchsias having white and red flowers, and which by the action of ammoniacal vapors become yellow, blue, and green. When the flowers have been subjected to the changes that color them, they will, if plunged in pure water, retain their new colors for many hours, after which they return to their primitive shade. Another interesting observation, due to Gabben, is that the flowers of the aster, which are naturally inodorous, acquire an agreeable aromatic perfume under the influence of ammonia. The flowers of these same asters, whose natural color is violet, become red when washed with diluted nitric acid.—1 *B*, XV., 42.

HOLLYHOCK FUNGUS.

The hollyhocks of Europe are threatened with destruction by the rapid development of a fungus known as *Puc-*

einia malvacearum, and probably imported from Chili, where it was discovered on *Althæa officinalis.* It was first observed in the neighborhood of Bordeaux, France, in April, 1873, on *Malva sylvestris*, and extended rapidly to other plants of the same order in the botanic gardens of that town. It appeared in Germany in October, having been found in England in the preceding summer.—12 *A*, *April* 16, 1874, 470.

PROPOSED WORK ON AMERICAN FOREST TREES.

Dr. F. B. Hough, of Lowville, New York, well known in connection with his efforts looking toward the protecting of American forests from destruction, proposes, should he succeed in obtaining at least two hundred subscriptions, to publish a work which will be of much interest to botanists, microscopists, and workers in wood. This will consist of actual sections of two hundred species of American woods, properly mounted for examination under the microscope, and suitably labeled, to be accompanied by text containing descriptions of the species represented, of their qualities and uses, with other statistical information. The whole will form three small quarto volumes, and the specimens will be prepared by Professor Nördlinger, of Hohenheim, who has already been connected with similar publications relating to the forest trees of Europe.

A NEW WORK BY MR. DARWIN.

Mr. Darwin has lately published in England, under the title of "The Movements and Habits of Climbing Plants," a reprint of his paper on this subject printed some years ago in the Journal of the Linnæan Society of London, which first attracted public attention to the remarkable phenomena connected with the rotation of climbing stems and tendrils. A good deal of fresh matter is also inserted. Mr. Darwin's work on "Insectivorous Plants" has met with a large sale, being already in a third edition. Professor E. Morren, of Liege, has published in the *Bulletin de l'Académie Royale de Belgique* a record of a series of experiments which, while they abundantly confirm the insecticidal powers of the leaves of *Drosera* and *Pinguicula*, lead him to doubt the power of absorption and digestion assigned to them by Mr.

Darwin. MM. Reess and Will, on the other hand, in the *Botanische Zeitung*, abundantly confirm Mr. Darwin's results in the case of *Dionæa* and *Drosera*, as is also the case with two independent series of observations carried on in England by Dr. Lawson Tait and Mr. J. W. Clark. The former gentleman claims to have established the absorptive power of the leaves of *Drosera* by planting in perfectly pure silver sand plants from which the roots had been entirely removed, and feeding them with extract of beef and phosphate of ammonia; the latter by feeding the leaves with bodies of flies soaked in a solution of citrate of lithium, and then finding the lithium in other parts of the plant by means of the spectroscope.

FERTILIZATION OF A FERN.

Mr. H. H. Babcock has lately communicated an interesting fact in regard to a well-known fern, the *Aspidium acrostichoides.* In this plant, at the time of maturing of the spores, the elastic band of each *theca* slowly straightens out, carrying the spores in a mass at its tip. After straightening and bending back as far as possible, it gives a sudden forward spring, projecting the spores in a shower. It then gradually resumes its original position, and then the *theca* presents the appearance of having simply been ruptured to allow the spores to fall out.

NEW WORK ON MEDICINAL PLANTS.

A new work has been commenced in London, under the title of "Medicinal Plants," to contain colored plates included in the pharmacopœia of Great Britain, India, and the United States, together with descriptions of plants, their nomenclature, geographical distribution, etc., and an account of their properties and uses.

I. AGRICULTURE AND RURAL ECONOMY.

NOXIOUS EXHALATIONS FROM THE MEADOW-SAFFRON.

Isidore Pierre communicates to the Paris Academy an interesting fact in regard to certain exhalations from the flower of the *Colchicum autumnale*, or meadow-saffron. In passing through a garden where these plants were in full bloom he accidentally held his hand near the flower, and found, after a few seconds, that his fingers had changed color, and assumed a yellowish-green tint, similar to that of the decomposing human subject. In a short time, however, the skin resumed its natural color. The precise character of this emanation Pierre was unable to determine. It could not be any solid substance, as it would have been much more persistent. He thinks, therefore, it is some extremely volatile liquid, which he proposes to investigate hereafter. He is convinced, also, that exposure to it produced certain uncomfortable sensations both in his hand and his mouth, calling to mind the toxical effects of the meadow-saffron, which under certain circumstances, especially when fresh, is highly poisonous.—6 *B*, *September* 14, 1874, 635.

VARIOUS INSECT-POWDERS.

The very great extent to which the various insect-powders now before the world are used for the destruction of noxious insects is well understood at the present time, the apparent quackery of the recommendations of the insect-powders being now well substantiated by abundant experience. Although insect-powders have been in use from time immemorial in China, Tartary, Thibet, etc., especially in enabling the herdsmen of the steppes to exist in company with the countless myriads of gnats and mosquitoes (for which purpose the substance is burned inside of the tent), it was not until 1846 that Zachrel, a Tiflis merchant, first introduced it for sale in Vienna, under the name of "Persian Insect-Powder." This was originally derived from two plants, the *Pyrethrum carneum* and *P. roseum*, both growing wild in the Caucasus, and largely cultivated there. Since that time the manufacture of insect-powder in Europe has increased wonderfully, and has been extensively introduced into America.

Quite recently a second variety of insect-powder has come into notice under the name of Dalmatian Insect-Powder, derived from the flowers of the *Pyrethrum cinerariæfolium*, a plant growing wild in Dalmatia, but whose cultivation is rapidly spreading. This is thought to be decidedly more powerful and more persistent in its action than the other kind, and justifies the higher commercial value. The discoid flowers of the plant are more powerful generally than the radiate; and as the former are larger, the greater activity of the Dalmatian flowers is due to the larger extent of the discoid portion in the Dalmatian plants. It is only after the flowers of the *Pyrethrum* are dried that their insecticide virtues are well developed. When fresh they exercise a slight action, but far inferior to that of the powder. It is said that in Vienna the druggists have on sale the dried flowers entire, as they are considered more effective and less liable to adulteration.—14 *A*, *March* 5, 1875, 503.

REMOVAL OF ACID FROM THE SOIL BY OIL-PRODUCING PLANTS.

It is said that land in the neighborhood of Torgau has been rendered fit for the production of wheat by planting it with rape-seed every two years; the oil-producing plants, like the *cruciferæ* in general, acting upon the soil like lime in the removal of acid.—9 *C*, *July*, 1874, 106.

AUSTRIAN PLAN FOR SUPPLYING AGRICULTURAL TEXT-BOOKS.

The need of appropriate text-books for instruction in various branches in agricultural science is every where very keenly felt. The Austrian Agricultural Ministry has attempted a very practical plan for supplying this want; namely, by offering rewards for authorship. Some ten different text-books for schools of various grades are desired, and sums varying from 900 to 2500 florins are offered for satisfactory manuscripts, the authors being allowed, in addition, whatever may be received therefor from the publishers.

CONTINUED SUPPLY OF GUANO.

More detailed accounts of a report which has been previously referred to, made by the embassador from Peru at

London, on the supply of guano in that country, have come to hand, and are calculated to relieve the fears so widely entertained of an early failure of the guano supply. On some forty-five different localities on the mainland and islands of the Peruvian dominions guano deposits are found, some of them amounting to millions of tons.

ARTIFICIAL GUANO.

The so-called Stummer's guano, prepared from human excrements by chemical treatment, by means of peculiar apparatus, has been in the market since 1869, in four different grades, adapted to different crops. The consumption of it has increased from 3000 hundred-weight, in the first year, to 10,000 in the past year. That exhibited at the Vienna Exhibition was in the form of a loose, dry powder, and was found, according to analyses by Moser and Siersch, to contain nitrogen, 1 per cent., 1 per cent., 1.13 per cent., 3.52 per cent.; phosphoric acid, 6.30 per cent., 10.69 per cent., 7.26 per cent., 15.06 per cent., in the four grades, respectively.—6 *C*, *July* 30, 1874, 308.

FIRST ANNUAL REPORT OF THE MASSACHUSETTS INSPECTOR OF FERTILIZERS.

The first annual report of the State Inspector of Fertilizers in Massachusetts, Professor Goessmann, of Amherst Agricultural College, contains considerable information about the more important of our fertilizing materials, their sources of supply, prices, and value.

From 30,000 to 35,000 tons of Peruvian guano are annually consumed in this country. This comes mostly from the Guanape Islands, and is somewhat inferior in quality to that formerly obtained from the Chincha Islands, the supply of which is nearly exhausted. Considering its composition, Peruvian guano is, when unadulterated, one of the best and cheapest fertilizers in the market. Of fish-scrap and fish-guano, large quantities are made on the coast of New England and Long Island. In 1872 some forty-two fish-rendering establishments were reported as in operation, producing 32,570 tons of scrap. Animal dust made of blood, meat-scraps, and bones from slaughter-houses; ground bones and bone-black waste, are also very valuable and of increasing importance.

It appears that superphosphates and ammoniated superphosphates constitute by far the larger part of our home-made fertilizers. Four fifths of the phosphoric acid in the superphosphates comes from South Carolina and Navassa Island phosphates. In the majority of cases the nitrogen is added in the form of some nitrogenous animal matter. Ammonia salts are very seldom, and soda or potash saltpetre more often used for this purpose. Crude sulphate of ammonia, Chili saltpetre (nitrate of soda), and German potash salts are also coming rapidly into favor. The higher grades of the German potash salts are much to be preferred to the lower, which contain large quantities of material of little fertilizing value; while the cost of freight in importation is as great as for the purer potash salts.

NEW GUANO DEPOSITS IN PERU.

Of all the states of South America, Peru appears to be most favored in regard to her financial condition, possessing as she does immense beds of guano, wholly controlled by the government, which furnish an ample revenue for all purposes. We chronicled not long since the discovery of new beds of this important manure, and we now learn that still later discoveries have been made of guano a few miles south of Iquique, which contain at least 20,000,000 tons of the fertilizer. Still other beds have also been found in the Bay of Independence, a few miles south of Pisco, the two together probably adding 25,000,000 tons of this substance to the treasury of Peru.

The quality of the new guano is said by Professor Raimoni to be excellent, although not containing quite as much ammonia as that formerly obtained from the Chincha Islands.—*Panama Star and Herald, March* 24, 1815.

CHEMICAL ANALYSES OF FERTILIZERS.

In the chemical examination of commercial fertilizers variations have often been found between the analyses of different samples of the same article. These differences may be due either to differences in the analytical methods employed or in the actual composition of the substances analyzed. To obviate the former source of error, the German experiment stations have given considerable attention to devising and adopting uniform methods of analysis. At a meeting, at Magdeburg, of the chemists of the stations, in 1873, a definite plan for the determination of phosphoric acid was agreed upon, to be used by all. But differences have been found in different analyses of the same fertilizer, even when the same method has been followed. Dr. Märcker, director of the experiment station at Halle, has lately sought to discover the cause of these variations. Superphosphates, as commonly manufactured, are by no means powder of uniform fineness, but often contain large particles that have clumped together in the treatment with acid. It would be natural to presume that these lumps would have the same composition as the fine powder. Such Dr. Märcker finds is not the case. A number of superphosphates, made from guanos, bone-black, and bone-dust, were sifted through a sieve whose meshes (including wire) were one millimeter wide, and the coarser and finer portions were analyzed separately.

The finer portions contained from 2.8 per cent. more to 4.3 per cent. less phosphoric acid than the coarser. If, therefore, in the analysis even of a superphosphate made from as finely pulverized material as bone-dust or bone-black, the clumpy portions are omitted and the finer portions analyzed, it is easy to see how incorrect results may be obtained.

From these observations Dr. Märcker concludes that "in the selection of samples of fertilizers for analysis the greatest caution should be observed on account of the difference in composition of the coarser and finer particles. It is necessary that the samples be so prepared and pulverized as to afford a safe guarantee for the uniform mixture of larger and smaller particles." "It would be just to expect manufacturers to see to it that fertilizers be well mixed and finely pulverized. Doubtless the best way to secure this would be found in the refusal on the part of consumers to buy imperfectly prepared articles."—*Zeitschrift des Landwirthschaftlichen Vereins der Provinz Sachsen*, 1874, No. 1, 12.

ABSORPTION OF AMMONIA, ETC., FROM SOLUTIONS BY THE SOIL.

Among the conclusions reached by Eichhorn, from a series of experiments in regard to absorption by the soil, it is stated that hydrous double silicates of alumina and lime, as chabazite and stilbite, absorb the ammonia from solutions of chloride of ammonium and phosphate of ammonia to a considerable extent, while the anhydrous double silicates, which are not decomposed by hydrochloric acid, do not absorb the ammonia, but those that are so decomposed do to some extent. By treatment with hydrate of lime these silicates take up water, and are rendered absorbent of ammonia, or, if so before, their absorbing power is increased. Carbonate of lime absorbs but little ammonia from a solution of chloride of ammonium, but somewhat more from a solution of the phosphate. Humate of lime and peat take out a considerable amount of ammonia and potash from solutions of their chlorides, with the passage of an equivalent amount of lime into the solution. Pure humic acid and peat, treated with hydrochloric acid, take up less ammonia and potash, under similar conditions. The chlorine in the preceding cases is not absorbed, but remains in the solution, in some cases combined with calcium in part, and in other cases in part as free hydrochloric acid. Phosphoric acid is largely absorbed from a solution of phosphate of ammonia by chabazite and stilbite, and also to a great extent by chalk, but the addition of the latter to the chabazite does not increase its absorptive power for phosphoric acid or ammonia. From a solution of a superphosphate the phosphoric acid is taken up very rapidly by humate of lime, and less rapidly, but completely, by acid carbonate of lime and chalk. Other bodies, as stilbite, brown hematite, kaolin, and humic acid, appear to absorb but little or no phosphoric acid from solutions of superphosphates.—14 *C*, CCXVI., 1875, 92.

FISH-GUANO, PARTICULARLY THE FATLESS, DRIED, SO-CALLED POLAR FISH-GUANO.

According to Dr. Vohl, large quantities of a small species of herring, so-called sprats (*Clupea sprattus*), collected upon the coast of England, and crushed, have been employed as manure for wheat and hops with good results. A process was also patented in England in 1854, by Pettitt, for the preparation of an artificial guano from herring by means of sulphuric acid. Analyses of three samples of this guano gave 4.1 per cent., 23.2 per cent., and 3.5 per cent. of phosphates of the alkaline earths; and 13.8 per cent., 10.6 per cent., and 11.2 per cent. of nitrogen, respectively. This inverse variation of nitrogen, compared with that of the phosphates, indicates that the sample in one case was made almost exclusively of the flesh, while in the other case it included also a large amount of bones. Analyses of the so-called Norway fish-guano, which first appeared in the German market in 1862, also show great variations in the percentage of phosphoric acid, doubtless due to the same causes. Although fish are very prone to putrefaction, still many of the fish-guanos decompose with difficulty in contact with water. The remarkable resistance to putrefaction of some samples was doubtless due to the presence of a large amount of fat, which caused them to be moistened with difficulty, and consequently to absorb water very slowly. The presence of such an amount of fat may have been the cause, in many cases, of the unsatisfactory results of experiments with fish-guano as a fertilizer, and may explain why its action was not as rapid and evident as that of bird-guano. Recently, however, this obstacle to the rapid and certain effect of fish-guano has been removed by Radde, of Hamburg, by the manufacture of so-called fatless, evaporated, polar fish-guano, in which a minimum of 8 per cent. of non-volatile nitrogen, and of 12 per cent. of phosphoric acid is guaranteed, and actual analysis of a sample gave a considerable excess above this minimum. This article is in the form of a fine, dry powder, of yellowish color, with a comparatively feeble odor. It absorbs water rapidly, and when moist putrefies readily at 52°, with copious formation of ammonia. It yields on ignition 37 to 38 per cent. of ash. The phosphoric acid is present as a tribasic phosphate, and the nitrogen in non-volatile combinations, from which ammonia is only liberated, as they decompose in the soil, thus affording a rich continuous source of nitrogen to the plants, in which particular it surpasses bird-guano. As a solid manure it can replace any artificial manure; in some cases, however, potash should be applied with it in the form of wood-ashes. As a liquid manure its value is indicated by the fact that 33 to 34 per cent. of it passes into a solution in cold water, which, on evaporation, affords a residue, which contains, when dried at 212°, in addition to the soluble phosphates, 15 per cent. of nitrogen. In the liquid form it has been found excellent for vegetables, fruit, and pot-plants. Experiments upon the conversion of the tribasic phosphates into a more soluble modification showed that sulphuric acid, by itself, was not adapted to the purpose, since not only the quantity of soluble phosphates formed was small in comparison with the amount of acid employed, while the nitrogen was reduced, but the resulting product had a tendency to become moist and form a doughy mass, unsuitable for a solid manure. By treating the guano first, however, with alkalies, and then with sulphuric acid, a most excellent potash manure was obtained, the employment of which, however, could only be profitable, under peculiar circumstances, where caustic alkalies are cheap.—14 *C*, CCXV., 1875, 460.

DETERIORATION OF SUPERPHOSPHATES WITH AGE.

Millot, in a recent communication, confirms his previous conclusion that the gradual decrease of soluble phosphoric acid in superphosphates, even with excess of sulphuric acid, is due to the formation of peculiar phosphates of alumina and iron. He states that, while all the phosphoric acid in a superphosphate manufactured from coprolites of the Ardennes is soluble immediately after its preparation, only 10 per cent. of the whole amount remained soluble after two years. After extracting it with hot water, until all the gypsum was removed, no lime was found in the residue, but the new compounds of iron and phosphoric acid—Fe_2O_3, $2PO_5$, and $2Fe_2O_3$, $3PO_5$. Alumina plays precisely the same part as the sesquioxide of iron, except that its phosphates are more soluble than the corresponding iron compounds. The use of phosphates of iron and alumina as fertilizers, therefore, seems rather unadvisable.—14 *C*, CCXVI., 1875, 92.

NEW MINERAL MANURE.

A substance has recently been offered in France as a valuable mineral manure. It is in the form of a bituminous slate of the lias formation in a finely powdered condition. This is prepared by M. A. Belenet, according to whom it contains about 20 per cent. of lime, 2 of soda and potassa, 1 of sulphur, 4 of mineral oil, and ½ per cent. of phosphoric acid, chlorine, and magnesia, with a trace of carbonate of iron and lignite. According to the inventor, this bituminous slate acts in a double way upon plants: first by its soluble chemical elements, and second by the creation in large quantity of ammonia and the nitrates by the combinations of the nitrogen, hydrogen, and oxygen of the air and of the water. The sulphur and the carbonates of iron oxidize in the air with the disengagement of heat, especially in the presence of moisture. The inventor enumerates experiments upon plants of different kinds, in all instances with very decided and satisfactory results, and it is especially recommended for moist siliceous sand wanting in calcareous matter. It is also used as a remedy against phylloxera.—1 *B*, *May* 2, 56.

LUSTRE SHEEP, A NEW BREED.

At a recent exhibition in Bremen the fleece of a yearling ram was exhibited, from South Australia, which was so remarkable for its fine silky lustre and softness, and the unusual length (over five inches) of the smooth, fine wool, as well as for its beautiful, almost dazzling whiteness, that all were satisfied that a fine, firm yarn, and very superior cloth, could be made from it. It was stated that it was a result of in and in breeding of Negretti sheep with Leicester (Lincoln) rams; the number of generations required was not stated, however.—23 *C*, *Aug.* 1, 1874, 345.

METHOD OF RETARDING THE DEVELOPMENT OF SILK-WORMS.

In view of the many diseases by which the native silkworms of France and Italy have been afflicted, during the past ten or fifteen years, it has become necessary to import a fresh stock from foreign countries, especially from China, Japan, California, Chili, etc.; but these eggs have arrived in Europe at a period when, if hatched out, the necessary food and attendance could not be secured. Quite recently a method has been adopted for retarding the development, by means of ice-chests especially constructed for the purpose, and this has been improved to such an extent that at present it is within the power of the silk-culturists to retard, almost indefinitely, the hatching of the worms, or at least to the most convenient season of the year. The eggs have been kept for many months in this way, and apparently without producing the least injury. In some cases central establishments have been erected, at which as many as 50,000 ounces of eggs have been kept at a time, these embracing not only the imported eggs, but those of domestic production. Natural ice is used wherever it can be had; otherwise machinery for its artificial production is made a part of the preserving establishments. It is calculated that a magazine of 100 square meters will comfortably accommodate 30,000 ounces of eggs, and a machine costing $2500 will, it is said, manufacture ice enough to keep the whole in good condition.—13 *B*, *Oct.* 31, 1874, 337.

PROFESSOR DUMAS AND THE PHYLLOXERA.

Professor Dumas maintains that of all the remedies for the *Phylloxera*, or grape-vine louse, the sulpho-carbonates, especially that of potash, are the only ones which are perfectly successful. This being strewed on the ground, the next rain helps it to penetrate the soil, and the *Phylloxera* is completely destroyed, as shown by experiments of Milne Edwards, Pasteur, and others in different vine-growing districts.

It is understood that Professor Dumas does not intend to claim the government reward of 100,000 francs for his discovery, on account of his being a member of the commission for testing the merit of different applications. He advises that attention be still directed toward finding something still better, or at least cheaper, as thereby likely to secure the prize.—12 *A*, *May* 20, 54.

PHYLLOXERA REMEDIES.

Professor Dumas, to whom we have already referred as having strongly advised the use of the alkaline sulpho-carbonates as a remedy against *Phylloxera*, has lately furnished a second paper on the subject to the Academy of Sciences in Paris. In this he reiterates his assertion that of all the remedies against *Phylloxera* the sulpho-carbonates are the most energetic, and that they merit in the highest degree the attention of all persons interested in the recuperation of the vineyards of France. He finds, as the result of more recent experiments, that, although so deadly to the *Phylloxera*, they render actual benefit to the vine, increasing the activity of its growth. The principal difficulty heretofore has been that these sulpho-carbonates are not produced in a commercial way, and that consequently their price is high. Professor Dumas, however, states that arrangements are being made for their manufacture on a large scale, and that at any rate the cost is inconsiderable compared with the benefits to be derived. One or two applications a year will be sufficient, and one of the best methods of making such application consists in mixing the substance with the manure and applying the two together.—6 *D, April* 26, 1049.

DESTRUCTION OF EARTH-WORMS ON GRASS-PLOTS, WALKS, ETC.

Sprinkling grass-plots, garden-beds, etc., with clear lime-water, in damp weather, when the worms are near the surface, in most cases several times, is said to be destructive of the worms, while it is rather beneficial than otherwise to the vegetation.—9 *C, July,* 1874, 105.

THE DESTRUCTION OF SMALL BIRDS THE CAUSE OF THE SPREAD OF PHYLLOXERA.

It has been suggested by Dr. Turrel that the rapid spread of the *Phylloxera,* or grape-vine louse, in France, is due more than any thing else to the rapid extermination of the small birds of that country. It is well known that a regular discharge of guns is heard all over France at certain seasons of the year, every person who can hire or borrow a musket entering into the crusade, and that an indiscriminate slaughter is made of birds of all kinds and characters. This view of Dr. Turrel is strengthened by the fact that in America, where the *Phylloxera* originated, its ravages have never been of any great extent. Even if the birds themselves can not reach the vine louse, it is suggested that other kinds of insects which are attacked by birds leave the vine in a weakened condition, and more liable to destruction by parasites. —12 *A, Nov.* 19, 1874, 56.

THE COTTON-WORM.

Dr. A. R. Grote advances a somewhat novel and at the same time encouraging theory in regard to the cotton-worm, so injurious to the agricultural interests of the Southern States. The result of careful inquiry into its history has led him to the inference that it is in reality a native of South and Central America, that its appearance in the United States is the result of immigration from the South, and that it dies out every year with its food-plant, the eggs which it lays not coming to maturity, being killed by the inclemency of the weather. He finds testimony that, for many years after the introduction of the cotton-plant into the Southern States, the cotton-worm did not appear, and that its existence in Southern Alabama but little preceded the late war. It is, however, capable of extended flights, as it has been observed in the Eastern States and also at Buffalo and Chicago. The supply of the insect is therefore maintained every year by means of flights from the South, which are somewhat capricious, and may be diverted out of their course by powerful currents of wind occurring at the time of their migration.

The inference drawn from these facts by Mr. Grote is that the process of artificial extermination may be simplified by limiting the period during which it can be successfully attacked, and by doing away with a certain class of proposed remedies. The agent employed to destroy the worm must be used against the first brood, as it appears in any given locality during its progress northward, and that, to be effectual, the action must be concerted in the application of the remedial agent.

Mr. Grote strongly recommends the introduction of the English sparrow, and additional legal protection to insectivorous birds, as absolutely necessary to the agricultural interest.—5 *D*, *Dec.*, 1874, 726.

HORSE-POX.

M. Depaul describes what he calls horse-pox in horses, the symptoms manifesting themselves in fever, prostration, a certain elevation of temperature, cough, engorgement of the submaxillary ganglions, and in having in the nostrils of the left side a series of circular projecting pustules, depressed in their centre and exhibiting characters similar to those of variole. These pustules form a distinct eruption on all parts of the body.

The experiment has been made of inoculating a child and a heifer with this substance; but the result has not yet been announced.

M. Bouley, the eminent veterinary surgeon of Paris, remarked, in the presentation of this communication to the

Academy of Medicine of Paris, that the facts were far from being exceptional; that that very morning he had found the same thing in a horse which was supposed to be affected with glanders. He stated that, in view of the possibility of confounding the two, the propriety of experiments, including children, was open to very grave doubts.—12 *B*, *May* 15, 422.

DRY ROT OF THE LEMON.

A serious malady has lately attacked the lemon-plant in various parts of the world, the result, as suggested, of the forced cultivation of the fruit. This is known as the "dry rot," and commences at the extremities of the plant or of the roots, and gradually spreads throughout the whole tree, drying up the sap in its course. It is suggested that by grafting cuts of the wild lemon-plant on the orange-tree a new stock may be obtained, and the fruit cultivated upon trees which have not been subjected to a forced growth.—12 *A*, *April* 6, 1875, 456.

PRESERVATION OF FRUIT.

The following method for the preservation of fruit has been patented in England. The fruit is placed in layers in a vertical vessel, separated by layers of pulverized white sugar, and is then covered with alcohol of 80° Gay Lussac. After twelve hours the closed vessel is inverted, and the maceration allowed to continue for twelve to seventy-two hours, according to the nature of the fruit, which is then removed and allowed to drain and dry. About two pounds of sugar and two pounds of alcohol are recommended for four pounds of fruit.—5 *C*, XXXII., 248.

NEW KIND OF SPINACH.

Several years ago a new kind of spinach was introduced into England, under the name of Australian spinach (*Chenopodium auriconium*), which, according to the unanimous opinion of connoisseurs, must be regarded as a valuable acquisition. It is perennial, very hardy, reaches a height of six inches, and affords a large quantity of tender leaves, which are soon reproduced after plucking. Its flavor is similar to that of common spinach, but not so grassy nor so harsh, and, in general, finer. It is best prepared by throwing the leaves into boiling water, and, after pouring this off, cooking it as usual. Its cultivation is simple. The seed may be sown in a hot-bed in March, for subsequent transplanting, or in the open ground in April or May.—9 *C*, *December*, 1874, 183.

BEST SHAPE FOR FRUIT-TREES.

The majority of a convention of German pomologists expressed a decided preference for the pyramidal form for fruit-trees. The advantages claimed for it are the minimum of shade, greatest strength, avoidance of severe wounding of the tree, production of better fruit, and at the same time fewer disadvantages from storms, weight of snow, excess of fruit, theft, etc.—5 *C*, *July*, 1874, 105.

NEW FACTS IN THE HISTORY OF THE POTATO BLIGHT.

An important step has been gained in the natural history of the potato blight. It is stated that Professor De Bary, of Strasburg, has detected the existence of "heteræcism," or an "alternation of generations," in the life history of the *Peronospora infestans*, the parasitic fungus which causes the disease. It is conjectured that the second form may possibly be found on clover.

INVESTIGATION OF THE POTATO DISEASE.

Announcement has already been made of the selection of Professor De Bary, of Strasburg, by the Royal Agricultural Society of England to make a series of investigations into the life history of the potato fungus, for the purpose of filling up a certain blank in our knowledge of the development of this destructive object. This gentleman, in carrying out his investigations, has lately discovered that the disease is not propagated by defective tubers, and that although the mycelium was distinctly apparent in the stalks of plants raised directly from diseased tubers, yet that neither gonidia nor germs were evolved. He also expresses the hope that he has at last discovered the resting-places of the oöspores, or the active primary germs of the fungus. This is the special point upon which further information is needed, and may suggest the proper means of preventing the continuance of the disease in any given locality by warning agriculturists against planting their potatoes in a spot where they must, at some time, inevitably be destroyed.—18 *A*, *Nov.* 20, 1874, 239.

FARLOW ON THE POTATO ROT.

A few years ago Dr. W. G. Farlow, of Cambridge, Massachusetts, visited Europe for the purpose of making a special study of the cryptogamic plants, and in this connection spent considerable time in the study of the subject, under the eminent Professor De Bary, of Strasburg. A recent number of the Bulletin of the Bussey Institution contains some of the results of this move on Dr. Farlow's part in an elaborate paper upon the potato rot. This is an important contribution to the natural history of the subject, embodying as it does the latest knowledge of this most destructive pest.

It should be remembered that Professor De Bary was commissioned by the Royal Agricultural Society of Great Britain to carry on investigations in this department, and the labors of Dr. Farlow give the results hitherto ascertained.

There are still some points in the natural history of the potato rot which are unknown, and which must be determined before any very positive preventive measures can be entered upon. Dr. Farlow sums up the whole matter by stating that there is no such thing as a specific against it; that is to say, there is nothing that will effectually protect the tubers and also prevent the further development of the fungus, as whatever completely destroys the fungus will be equally fatal to the potato itself; so that the only thing that can be done is to prevent as much as possible any harm to the plants in which the mycelium already exists, and the spread of the disease to healthy plants.

If the moisture in the air, about the time when the disease is likely to appear, say from the first of July to the middle of September, can be controlled, the mycelium would not increase to any extent so as to produce practically any harm. Unfortunately this can not be done; but the land can be thoroughly drained, or dry soil used for planting. The wetter the soil the more liable is the potato to rot. As the disease does not appear until about the first of August, early potatoes should be less likely to rot than late ones. But exactly what variety farmers should plant is not a question for the botanist. Although certain potatoes seem to resist the disease better than others, yet none are free from liability to decay. Dr. Farlow remarks that the precautions which should be taken to prevent the extension of the disease will be more definitely known when the plant in which oöspores are produced has been discovered. At present we can not say with certainty that these are found either in clover, wheat, oat, or rye straw, and therefore the prohibition to plant after any of the above-mentioned crops is without foundation. It is thought probable, however, that the oöspores of *Peronospora infestans* will be found concealed in some common plant eaten by cattle; and as these oöspores are so tough as not to be affected by passing through the alimentary canals of animals, the chances of avoiding the rot are greater when mineral manures are made use of than animal. Dr. Farlow also puts in a word of caution in reference to the fungus of the lettuce, which he states is increasing very rapidly in New England, and is a subject worthy of serious consideration.

CULTIVATION OF THE ASPARAGUS IN FRANCE.

There are few vegetables in which the result of special care in cultivation has been more marked than in the case of asparagus, which, from the old-fashioned stringy, slender, and tough spike, has been converted into a tender, succulent mass of agreeable food. This result is due particularly to the labors of the French, asparagus having been cultivated in France for a long time, especially in the vicinity of Argenteuil, near Paris.

In former times the beds in which this plant was cultivated were managed without reference to other crops; but more recently the plant has been reared in the vineyards, the grape and the asparagus agreeing very well together. At present the vineyards of Argenteuil furnish from eight to twelve hundred dollars' worth of asparagus annually per hectare (2½ acres), or from three to five hundred dollars' worth per acre.

The asparagus bed is started in March or April, with shoots obtained by sowing under glass in open, light, well-worked soil, isolated as much as possible from surrounding vegetation, the earth being dug out to the depth of about eighteen inches. Trenches of these dimensions are first prepared, being separated from each other about four inches, in the centre of which the shoot is placed, upon a little hillock of earth, with its roots carefully spread out. The whole is then carefully covered with earth and with a small quantity of manure. The air must be allowed to penetrate the bed, this being secured by stirring up the soil from time to time.

Care must be taken to destroy or remove snails, insects, and other things injurious to the plant. In October, during dry weather, the stems of the asparagus are to be cut at a height of about six inches above the surface of the ground. A small quantity of manure is then to be placed around the plant and covered with a thin layer of light earth, so as to form a little hillock around the shoot some inches in height. The same precautions are to be taken each year; but it is not until the fifth year that the asparagus can be collected to advantage.

The shoots should be gathered once or twice a day, preferably in the morning, and should never be cut, but should be bent a little downward and then slightly twisted, thus detaching the top readily from the stump. By taking all the necessary precautions, especially in preventing too great action of light upon the asparagus, plants of extraordinary dimensions and excellence can be obtained, varying in price in Paris from one fourth of a franc to five francs each. A single plant has been known to furnish five dollars' worth of asparagus in a single year. When it attains, as it sometimes does, an excessive growth, the plant loses its original form and becomes very much flattened, the edges curling round in the form of a half-closed tube. This is technically termed fasciation, and frequently occurs in other plants.—13 *B*, *July* 10, 81.

NEW DISCOVERY IN CONNECTION WITH THE POTATO DISEASE.

There has been hitherto one "missing link" in our knowledge of the life-history of the potato-blight—*Peronospora infestans.* The non-sexual mode of reproduction by gonidia, or zoospores, has long been known; but the sexual mode of reproduction has eluded observation. This link has now been supplied through the researches of Mr. Worthington Smith, who described his discovery in a paper read at the last meeting of the Scientific Committee of the Royal Horticultural Society, and published at length in the *Gardener's*

Chronicle for July 10, 1875. He finds the female organs, the "resting-spores," or unfertilized "oospores," and the male organs, or "antheridia," in the interior of the tissue of the tuber, stem, and leaf when in a very advanced stage of decay; and he has actually observed the contact between the two organs in which the process of fecundation exists. In some remarks made at the meeting of the British Association last year, by one of our high authorities, it was suggested that we have in the *Peronospora* an instance of the phenomenon not infrequent among fungi, known as "alternation of generations;" and that the germination of the true spores of the potato-blight must be looked for on some other plant than the potato. Mr. Worthington Smith has, however, looked nearer home, and has proved at all events that the suggestion is not verified in every case.

CONTINUOUS CORN-GROWING.

Some agricultural authors insist that corn-growing can not pay in England, and that the increasing expense of cultivation must shortly consign large tracts of arable land to grass. Two spirited agriculturists, Messrs. Prout and Middleditch, of England, have helped materially to solve some of the difficulties of clay farming. They have demonstrated the agricultural capabilities of stubborn clays, for their practice shows how successfully they may be cultivated; have profitably grown cereals on the same heavy land for several consecutive years, and continue annually to dispose of the whole of the increased products. Mr. Prout's farm comprises 450 acres, and was in such poor condition that it was with difficulty rented at twenty shillings per acre. The land was wet, and was overrun with weeds and overshadowed with crooked fences. The best portions of it produced twelve bushels of wheat and twenty bushels of oats per acre per year. Since 1861 Mr. Prout has built commodious dwellings for his laborers, dug new wells, ditched and drained the whole farm, altered the fences and hedge-rows, and reclaimed the waste land to such an extent that eighteen acres have been added to the productive area of the farm. From the beginning Mr. Prout has employed steam-power, and at every practical step the steam-plow so effectually disintegrated the formerly sour, stiff clay, admitting frost, air, and sun, that after the first few years full crops grew with a little extra manuring; and even cereals were grown consecutively with the employment of about twenty shillings per acre of artificial manures. Experience, however, has shown that to prosecute his system successfully, fifty or sixty shillings per acre of manure must be applied annually.

But Mr. Prout has done more than to bring into superior and profitable cultivation 450 acres of heavy clay land, worth thirteen years ago not more than twenty shillings per acre. He has inaugurated an almost original system of husbandry. All ordinary rotations are ignored; corn crops follow each other on the same field for several consecutive years. Wheat has been grown for five successive years, and the cereals have been repeated for eight years. Mr. Prout is no mere theorist. He brought to his labors the experience acquired from many years in Cornwall and in Canada. He determined to sell, year by year, the whole of his growing crops, and to restore an equivalent in the form of portable fertilizers. For his consecutive corn crops Mr. Prout only desires deep, thorough cultivation, extirpation of weeds, and a regular supply of manure. His crops are sold a week or ten days before they are ready for the harvest, the neighboring farmers being his principal buyers, and superintending their own harvesting and threshing. The labor question troubles Mr. Prout less than many of his neighbors. His steam-tackle economizes both horse and hand labor, and keeps his labor account under thirty shillings per acre. He expends upward of £1200 annually on portable manures. Bones, mineral superphosphate, guano, and nitrate of soda are generally preferred. The average annual receipts of his farm are £4800, out of which it is estimated that he has an annual profit of £825. That the consecutive grain crops taken off have not exhausted nor deteriorated the land is evident from the improved quantity and quality of the growing crops, and the increased value of the farm, which would now bring double the price paid for it by Mr. Prout. Very few land investments, or any description of investments, pay, like Mr. Prout's, a fair interest on the outlay, and double their value in thirteen years.

The farm of Mr. Middleditch, before referred to, has been treated in a very similar manner, and with the same encouraging results.

FIELD EXPERIMENTS WITH VARIOUS FERTILIZERS AT THE BUSSEY INSTITUTION.

The "Trials of Various Fertilizers upon the Plain Field of the Bussey Institution" of Harvard University, by Professor F. H. Storer, are much more elaborate, accurate, and useful than any other field experiments ever attempted in this country, and will, if continued, excel in these respects all European ones except those of Lawes and Gilbert at Rothamstead, in England.

The motive of these experiments has been "to determine, if possible, what kinds of fertilizers, among those ordinarily obtainable in Boston, are best fitted to increase the yield of crops grown upon a field that had been chosen as the typical representative of the thin, light, 'leachy' soils which so frequently overlie the gravelly drift in New England." The plan has been to divide the field into plots, and to raise upon them different crops with different kinds of manure, repeating the same crop on the same plot, with the same manure, year after year. Three kinds of crops—barley, beans, and ruta-baga—were grown. Yard and stable manure, muck, fish-scraps, lime, bone-meal, superphosphates, salts of ammonia, potash and soda, and other fertilizers were used, either singly or in combination with each other. The experiments were commenced in 1871, and reports for four years (1871–4) are now issued.

An idea of the magnitude of the work may be obtained from the fact that some 285 experimental plots, each five meters (= about one rod) square, have been cultivated, some during the whole, and others for part of this time. The experimental crops suffered somewhat from the casualties to which crops in general are exposed, such as heavy rainstorms, depredations of animals, failure from bad seed, and particularly from drought. The repetition of the experiments through a series of years, however, served to make up for the disturbances from these causes, so that the general results are, on the whole, quite conclusive and reliable. The conclusions apply, of course, to such soils as that of the experimental field, and only in a more limited degree to others.

In one respect, however, these experiments have a very great value. Most of the investigations upon which the accepted theories of agricultural science are founded have been made in Europe, where circumstances obtain, in many respects, different from our own. And so long as we depend entirely upon results of European experience to guide our practice, we shall run the risk of falling into error. A number of illustrations of this truth are brought out by these experiments of Storer.

In the experiments described above it was found that potassic manures yielded the best crops, while phosphates and nitrogenous manures did but little good, and in some cases positive harm. The largest crops were obtained with farm and city stable-manure, and with wood-ashes. Nitrate, sulphate, and carbonate of potash (pearlash) likewise brought large returns. In a summary of comparative results, wood-ashes proved more efficacious than any other single fertilizer, the yield being larger than with either yard or stable manure.

Professor Storer concludes that the soil needed potash rather than phosphoric acid or nitrogen. "The addition of potassic manures to the soil manifestly enables the crops to make use of a certain store of phosphoric acid and nitrogen that the land contains. It is clearly shown, moreover, that the amount of available potash in the soil must be very small, since neither the phosphatic nor the nitrogenous manures by themselves, nor mixtures of the two, such as several of the so-called superphosphates are known to be, could enable the crops to get enough potash from the soil to keep them from starving after the first year." And further, "It is plain that the soil of this field, like those of thousands in New England, needs fertilizers that are rich in potash, and that, under the existing condition of things, no advantage can be gained by applying mere phosphatic and nitrogenous fertilizers to the land. . . . If only potash enough be given to this soil, the latter can of itself supply all the other ingredients that compose the food of plants, at least for the term of years during which the experiments lasted, and for as many more, of course, as the store of phosphates and nitrogen may hold out. . . . The crying want of the land is for potash, and potassic manures should be applied to it to the well-nigh complete exclusion of all other fertilizers until an equilibrium can be reached."

Besides the results of his own experiments, Professor Storer finds proof of the lack of potash in New England soils in the common impressions and practice of farmers. Good farmers about Boston maintain that wood-ashes and the so-called "long" horse-manure from city stables, which contains a good deal of straw, are worth more than night-soil and Peruvian guano. These all, except the ashes, are rich in nitrogen, and all contain phosphoric acid. The night-soil, and particularly the guano, a good deal. But the night-soil and guano are poor, and the ashes and strawy horse-manure rich in potash. The fact, then, that on soils in the district near that of the experiments ordinary practice shows the long horse-manure and ashes to be more useful than guano and night-soil is an additional proof of the lack of potash in these soils. The guano and night-soil, with their large supplies of available nitrogen, would temporarily stimulate the growth of plants, but the result would be a speedy exhaustion. That is to say, these fertilizers would enable the plants to make speedy use of the small amount of available potash in the soil; but thereafter, until the potash was re-supplied, a large yield would be impossible.

The widely prevalent opinion that, in nearly all cases, nitrogen and phosphoric acid are the only important ingredients of commercial manures is of essentially transatlantic origin. In European practice, the lack of phosphoric acid and nitrogen has been felt more than that of potash. Mr. Lawes, who, with Dr. Gilbert, has conducted the famous experiments at Rothamstead, England, states that "the only two substances really required in artificial manures are, first, nitrogen; second, phosphoric acid;" and that "potash is generally found in sufficient quantities in soils, and the artificial supply is not required." This opinion is evidently based upon his own experience and observations on the other side of the Atlantic. In England and on the continent of Europe the great bulk of commercial fertilizers are bought for the phosphoric acid and nitrogen they contain, though in Germany, especially, potash salts are coming into very general use.

As Professor Storer points out, the circumstances affecting the amounts of plant-food in the soil in New England have been different from those in Europe. Here grass and forage crops, with very little grain, make up the chief produce of the soil. But little dung has been applied, nor has the custom of returning straw to the soil ever prevailed as in Europe. Clearing land by burning wood has probably aided the exhaustion. "No doubt other matters besides potash have been removed from the land by these practices, nor that, in many instances, phosphates are needed also; but the evidence would seem to show that, in the present case, the supply of potash originally contained in the land has given out first. It is no great matter of surprise that this thing should have occurred in a country mainly devoted to grazing and the growth of forage. If New England had been a grain-growing country, phosphoric acid might perhaps have been its weakest point.

In the field experiments of Messrs. Lawes and Gilbert, in England, alongside of heavy crops that have been raised, year after year, on manured plots of land, smaller yet not inconsiderable yields had been obtained in successive croppings, on similar plots, without manure. This has served to bring out very forcibly the fact that soils have a certain capability of re-supplying the plant-food removed in cropping by the working over of materials present in greater or less quantity in every soil, into forms fit for the nourishment of the plant. To this restoring power the term "natural strength" has been applied.

In Storer's experiments, crops of some, though limited, size were obtained without manure. By adding moderate quantities of appropriate manure a much greater yield was obtained. But an increase in the manure above this amount was not followed by a corresponding increase of crop. Very heavy manuring was not economical.

In the causes of this are to be found some principles of great practical importance.

From the fact that only very small crops were obtained without manure, Storer concluded that the natural strength of his soil, in the sense above referred to, is not great.

But there is another sense in which this term may be used, and another condition of the capability of a soil for producing crops, besides its capacity for working over into available forms the stores of plant-food it may contain. It is important that it should be able to utilize, economically, the manure it receives. And this latter is an important factor of the natural capability of a soil.

The soil experimented on by Storer was deficient in both these respects: in capacity for yielding good crops from its own stores, and in power to make large returns for large supplies of manure given to it. The reasons are very clearly set forth in Storer's report. In order that plants may grow well, each one of a number of conditions must be fulfilled. Not only must all the essential ingredients of plant-food be present in abundance, but there must be proper supplies of light, heat, air, and moisture.

"The experiments of the German chemist, Hellriegel, show most clearly the enormous influence that is exerted upon the quantity of a crop whenever one of these conditions is unfulfilled, or only partially fulfilled. By attending to all these particulars, Hellriegel has succeeded in growing, year after year, several grain crops, much larger, healthier, and more perfect in every respect than have ever been met with in field practice. He has been able, moreover, to produce at will plants of determinate size and weight by varying the conditions aforesaid, though the supply of food was unchanged." In fact, within certain limits he was able to make the size of his crops very nearly and regularly proportional to the amount of water they received.

Now the application of these principles to Storer's experiments is plain. The soil is peculiarly subject to drought. Without an adequate supply of moisture, crops grown upon it are unable to make full use of the plant-food contained therein. Hence heavy manuring of such soils is not economical.

There are many practical and theoretical farmers who advocate with little discrimination the doctrine of "high-farming," and point to European practice in support of their view. One limitation to this doctrine is forcibly illustrated in Storer's experiments. As was said above, the soil on which these experiments were made was not "strong" enough to give manure the support it needs in order that its fertilizing constituents may be used with advantage. This was due to its lack of depth, and above all to its lack of water. "Like thousands of others in New England, their field has a *certain natural but limited capacity to profit by the application of* *manure.* . . . The results of three years' experiments show conclusively that under the conditions which now obtain the land is unfit for any system of 'high-farming.' On the contrary, to be farmed with profit, it must be given over to some system of low-farming, where expenditures for labor, tillage, and fertilizers shall be small and the crops proportionally light." True economy would consist in learning how much production can be profitably obtained, to depend upon the natural strength of the soil so far as it will avail, and only supply manure for the rest.

And the same principle applies to more than the light, dry soils of this country. In the best farming countries of Europe, from which most of our agricultural science hitherto has come, land is very dear, capital is comparatively cheap, and there is a market near every farm. There, as Professor Storer says, "the problem may be almost said to be: Given standing-room, how to get the largest possible yield from the land; and that is profitably done by 'high-farming,' even though some materials are thus stored up in large excess in the soil." With us land is cheap, and capital needed for manure and labor dear, and the market often distant; and the aim of the farmer ought generally to be "to use up the natural force of his land most fully, without injuring or in any way weakening it, and, slowly if need be, but with constant profit to himself, to increase the original fertility until it is completely in accord with the other circumstances by which the profits of his farm are limited and controlled."

A great many attempts to renovate worn-out lands by the use of commercial manures prove unsuccessful. In such cases failure is apt to be ascribed to the poor quality of the fertilizers used, and the manufacturer or seller is accused of dealing in spurious wares. That such accusations are sometimes well-founded is only too true. But articles of fair or even the highest quality are often misapplied, or the conditions of growth dependent upon moisture or other agencies are unfavorable. The ill results are oftener due to these causes than to frauds in fertilizers. In some of his field experiments Professor Storer obtained smaller crops of beans and barley on plots treated with bone and other phosphates than on contiguous plots which received no manure at all. The phosphates then, instead of increasing the crops, actually reduced them. This injurious action of phosphates Storer has known only on poor soils. To investigate the cause, he "tried a number of experiments in pots with the view of determining how large an amount of phosphatic manure may be safely applied to sterile land. From the results obtained it would seem that bone-dust and other phosphates, when present in too large a quantity, may exert an exceedingly hurtful influence upon the development of the plumule, or first sprout that springs from the seed, especially at the time when the young shoot is ceasing to draw nourishment from the seed, and is beginning to live upon matters derived from the soil and air. It appears that the young seedling can not endure the presence of a certain excess of phosphate of lime; at least when the soil in which it stands is too poor to supply at once all the food the plant may need.

The superior value of superphosphates is, in general, ascribed solely to the fact that, being in the soluble form, their phosphoric acid is more readily imbibed by the roots of the plant, and they thus become immediately available as plant-food. In view of the fact that contact of too much phosphate with the seed may cause the young plant to perish almost at its birth, Professor Storer suggests that the superphosphate may be better, because safer. The soluble phosphate will be more uniformly diffused through the soil, so that no hurtful excess may in any place come in contact with the roots.

J. PISCICULTURE AND THE FISHERIES.

REPORT OF THE FISH COMMISSIONER OF CANADA.

The report of Mr. William F. Whitcher, Commissioner of Fisheries of Canada, made to the Minister of Marine and Fisheries, on the operations of his department for 1874, is, like its predecessors, a document of very great value, and especially so on account of the very full and accurate statistics of the yields of the products of the sea and the rivers of the various parts of the Dominion.

According to this report, the condition of the fisheries generally is improving, their money value in 1874 amounting to $11,681,886, or an increase of nearly $1,000,000 over that of the preceding year. This, of course, embraces fish and fish products for exportation, while ten per cent., it is thought, should be added to represent the domestic consumption. The products of British Columbia, Manitoba, and the northwestern territories are not communicated.

Of the sum mentioned, Nova Scotia is credited with $6,652,000, New Brunswick $2,685,000, and Quebec $1,608,000, with smaller quantities for Ontario and Prince Edward's Island.

The report also includes an account of what has been done in the Dominion in the way of artificial propagation of the salmon; and we are informed that there are five fish-hatching establishments now in successful operation—namely, at New Castle (Ontario), Tadousac, Gaspé, Restigouche, and at Newcastle (New Brunswick). The quantity of eggs laid down in these five establishments exceeds four millions, of which about eighty-three per cent. will probably become young fish. Similar establishments are recommended for Nova Scotia, Prince Edward's Island, the Eastern townships, and on Detroit River, near Sandwich. A favorable place has been found near the Narrows, among the Thousand Islands, on the Canadian shore of the River St. Lawrence, for hatching and rearing such fish as bass, pickerel, and muskallonge.

Special attention is called by the Commissioner to the importance of the salmon of British Columbia and Frazer's

River. Acknowledgments are made to the United States Fish Commissioners for the donation of a number of eggs of the California salmon, which were hatched at the establishment at New Castle, Ontario.

Of interest to some American salmon fishermen, who resort in so great numbers to the rivers of the Dominion for the purpose of taking salmon with the rod, is a table, giving the number of captures in all the rivers in the provinces of Quebec and New Brunswick. The largest credits are 1311 to the Restigouche, and 654 to the Nepissiguit. Next to these the Great Cascapedia furnished 418 fish, of an average weight of twenty-three and a half pounds, the largest fish weighing forty-eight and a half pounds.

NINTH ANNUAL REPORT OF THE MASSACHUSETTS COMMISSIONERS OF FISHERIES.

The Massachusetts Commissioners of Fisheries have published their ninth annual report, for the year ending January 1, 1875, which, like its predecessors, occupies a prominent part in the histories of state and national measures taken for multiplying the food fishes. The principal work of the Commissioners consisted in hatching the eggs and planting the young of the California and Maine salmon, and the hatching of shad in the Merrimac River at North Andover. A few land-locked salmon were also obtained from Sebec, and distributed to different parts of the state. The number of shad caught at Andover, in 1874, was 1680, which furnished 6,249,000 spawn. Of these 3,500,060 were hatched and distributed in various waters of the state. The average of the yield of eggs was 10,278 to each female.

NINTH REPORT OF THE FISH COMMISSIONERS OF CONNECTICUT.

The ninth report of the Fish Commissioners of Connecticut, made to the General Assembly at the May session of 1875, has been published by these gentlemen, and contains the usual evidence of their activity and energy in prosecuting the labor intrusted to them. They report a good deal of work in stocking the ponds of the state with black bass, as also in the hatching of shad in the Connecticut River, and their distribution. They are quite satisfied that the measures taken by the state to multiply this last-mentioned fish have been successful, the number caught during the past season having been unusually great, and the price being correspondingly cheap, while, in addition to all this, the average size of the fish has been increased.

They report considerable difficulty in carrying out the laws of the state in reference to the establishment of fish-pounds in Long Island Sound, having been enjoined from proceeding against certain delinquents by the societies sustaining such establishments.

They have much to say also of the prospect of success in regard to the introduction of the California salmon from the United States fishery on the M'Cloud River, thinking the fish to be eminently adapted to the waters of their state.

FIRST REPORT OF THE COMMISSIONERS OF FISHERIES OF MICHIGAN.

The first report of the State Commissioners and Superintendent of Fisheries of Michigan for the years 1873–74 has just been published, and exhibits the operations of a very energetic and active board for the period mentioned. A hatching-house has been established at Pohagan, near Niles, where large numbers of whitefish, salmon, and salmon-trout have been hatched out, and distributed throughout the state. A great deal has already been accomplished by means of the liberal appropriations on the part of the state toward restocking the waters with useful fishes; and should these labors be continued for a few years, Michigan will have but little to ask for in reference to the restoration of her former very extensive fishery privileges.

The Commissioners first appointed were Governor John J. Bagley, George Clarke, and George H. Jerome. Mr. Jerome has, however, been appointed Superintendent of the State Fishery Establishment, and his place on the Commission has been filled by the appointment of Mr. A. J. Kellogg.

The fish most important to Michigan at present is the whitefish, which occurs on every side of the state, and has heretofore constituted the basis of a very extensive business. The decrease, however, has been more and more marked year by year, and it is quite probable that but for the efforts which have been initiated, and are likely to be continued, on the part of the state, the economical value of these fish would have been practically done away with. By restoring their original abundance, and even more, and adding the shad, the California salmon, and the Eastern salmon to the number of the inhabitants of the Great Lakes, and introducing the land-locked salmon into the lakes of the interior, the problem of cheap food for the people in Michigan will be measurably solved.

FIRST ANNUAL REPORT OF THE FISH COMMISSIONERS OF MINNESOTA.

The first annual report, for the year 1874, of the State Fish Commissioners of Minnesota has just been printed by order of the Legislature. In this the Commissioners, Messrs. Day, Austin, and Latham, call attention to the great proportion of water acreage in Minnesota, and the advantages of the state for fish-culture. According to their calculation, there are, exclusive of Lake Superior and Lake Pepin, and of rivers, no less than 1,601,848 acres of inland lakes alone, or about three and one third acres of water to every hundred acres of land. In addition, the Commissioners claim for the state the existence of some of the most important food fishes of the West, chief among which they consider the whitefish. This is of very great importance to the inhabitants of the state, and nearly 20,000 Indians in Northern Minnesota subsist almost exclusively upon it. An account of the measures taken for the disposition of the shad and salmon placed at their command by the United States Fish Commissioner is also presented by them.

FIFTH REPORT OF THE FISH COMMISSIONERS OF RHODE ISLAND.

The fifth annual report of the Commissioners of Inland Fisheries of Rhode Island, made to the General Assembly in January, 1875, has been published, and contains an account of what has been done by the Commissioners in pursuance of their trust. The efforts of the Commissioners have been largely directed toward restocking the rivers of the state with salmon, of which about 200,000 young were introduced into sundry rivers, particularly the Pawtuxet. Many young salmon were seen in the stream during 1874, and the prospect of success is very encouraging.

The Commissioners render their acknowledgments to the United States Fish Commission for a large supply of young shad placed in the Pawtuxet and other rivers.

An extended distribution of eggs and spawn of trout was also made. A good deal was also done with black bass; and it is probable that before long every considerable body of water in the state will be supplied with this fish.

In an appendix to the report is given a list of the various laws that have been passed for the regulation of the fisheries in Rhode Island.

REPORT OF THE FISH COMMISSIONERS OF PENNSYLVANIA FOR 1874.

The State Commissioners of Fisheries of Pennsylvania have published their report for the year 1874, and give a satisfactory exhibit of their activity during the year. They remark that, owing to some as yet unexplained fatality, the indications of the increase of black bass during the year are not so great as they had expected, and that the number of young fish caught in the streams is much less than that of the previous seasons. They suggest that this may be in part due to the covering up of the spawning-beds and the destruction of the spawn in consequence of heavy freshets during the critical season.

Attention is called to the destructive character of the pound nets and other fishing improprieties in Lake Erie, and the action of the Legislature is invoked for a remedy.

The fish-way, constructed at great expense, for the passage of shad at the Columbia Dam, the Commissioners believe, with the alterations recently made, will be adequate to its object. During 1874 the low stage of water and other circumstances combined to prevent the upward passage of the fish for a certain part of the season, although, when a sufficient flow passed through the chute, a considerable number are supposed to have ascended.

The shad-hatching operations of the past season were conducted on the Susquehanna River, just below the Columbia Dam, and from 174 spawning fish 3,205,000 eggs were obtained (an average of rather less than 18,500), and 3,065,000 young fish hatched out. The work extended from the 29th of May to the 24th of June. The highest temperature observed in the river during the period was 82° (on the 9th of June), the water being only 75° on the 22d.

The report gives a table of the distribution of California salmon and the salmon of Maine from eggs received from the United States Fish Commission and hatched out at the state establishment at Marietta; as also of another supply hatched out at Dr. Slack's place at Troutdale, New Jersey. The localities where these were planted are also indicated in the report.

The Commissioners are satisfied that the efforts in regard to California salmon have proved a success, and that after a few years both the Delaware and the Susquehanna will abound in this important addition to the food resources of the country. They remark that they have seen the young California salmon, from four to eight inches in length, taken with the hook and line.

A good deal was done by the Commissioners in the distribution of salmon-trout in the rivers of Pennsylvania, 67,600 having been planted in different localities.

REPORT OF THE FISH COMMISSIONERS OF NEW HAMPSHIRE FOR 1874.

The report of the Commissioners of Fisheries of the State of New Hampshire, for 1874, has just been published, and gives an account of the labors of the new Commissioners, Messrs. Noyes, Wadleigh, and Fifield, who superseded the former officers about a year ago. Owing to the short period during which they have held office, they have not much to record, although they promise to carry on their work as vigorously as the means at their command will allow.

They propose a somewhat different method than that usually employed for stocking the waters, namely, the transfer of parent fish themselves, instead of depending upon the eggs or the young. They announce that they have made arrangements to put several thousand whitefish from Lake Champlain into waters of the state best suited to their propagation. They intend to introduce shad into some of the larger rivers as soon as they can obtain the mature fish, deeming it far preferable to the introduction of the eggs or young fry. If they can devise some method of keeping large shad for even a few hours in a confined body of water, and of transporting them, they will accomplish an important feat in fish propagation, as, so far, the most careful manipulation has been unsuccessful. Even where the fish have been caught in large seines, and simply lifted by net or by hand into an adjacent inclosure for the purpose of keeping them until the eggs were entirely mature, they have always died in a very short time, possibly owing to the extent to which the scales become detached, and the consequent injury to the system.

SECOND REPORT OF THE FISH COMMISSIONERS OF VERMONT.

The report of the Fish Commissioners of the State of Vermont (Drs. Edmunds and Goldsmith) for 1874 (being their second) has been published by the Legislature, and contains an account of the measures adopted by the Commissioners for restocking the rivers of the state with useful food fishes. The importance of this interest to the state is shown, according to this report, by the large water area possessed by Vermont in proportion to its entire extent, there being scarcely a town without some natural body of water in it, susceptible of being made profitable to the people if suitably stocked with fish. According to their estimate there are 145 natural ponds in the state, having an area of 50 acres and upward, making an aggregate of over 77,000 acres now inhabited by worthless kinds of fish, of no economical importance. These can be filled, after a time, with suitable species, adding much to the resources of the state. The action of the Commissioners has related more particularly to the introduction of shad and salmon, which, with the assistance of the United States Commissioner of Fisheries, they have been enabled to effect on a large scale; the aggregate of 35,000 California salmon, 160,000 Maine salmon, and 775,000 shad having been safely planted in the waters of the state during the year.

FIRST REPORT OF THE FISH COMMISSIONERS OF WISCONSIN.

In the spring of 1874 Messrs. William Welch, A. Palmer, and R. R. Hoy were appointed by the Governor of Wisconsin Fish Commissioners of the state, in compliance with an act of the Legislature. Their first report has now been published, in which they give an account of their labor during the year. In consequence of the late period at which their appointment was made, and the limited amount of money at their disposal, little was accomplished; but they express the hope that, with proper support from the Legislature, they will be able to do a great deal in increasing the supply of fish food. They also strongly urge the propriety of establishing a state hatching-house, in which eggs of the whitefish and the various species of salmon can be developed, and distributed to suitable waters throughout the state. They point to the great number of lakes in Wisconsin, there being no less than 225, covering 388 square miles, and occurring in sixteen counties alone. These are at present comparatively unproductive, but are capable of sustaining a very large number of fish.

THIRD ANNUAL REPORT OF THE AMERICAN FISH-CULTURISTS' ASSOCIATION.

The third annual report of the American Fish-culturists' Association, just published, contains the proceedings of the annual meeting held in New York on the 10th of February, 1874. On this occasion a large attendance was present, consisting of the most prominent fish-culturists of the country, together with the Fish Commissioners of the several states and of the United States. The most important communications made were as follows: On "The Introduction of Eastern Fish into the Waters of the Pacific Slope," by Livingston Stone; on "The Experiences of a Practical Fish-culturist," by Seth Green; "Salmon-breeding at Bucksport," by Charles G. Atkins; "Report on the Work of the United States Fish Commission," by S. F. Baird; on "The Fish-Ways of Pennsylvania," by James Worrall; and on "Laws for the Preservation of Fish," by Charles Halleck.

MEETING OF THE AMERICAN FISH-CULTURISTS' ASSOCIATION.

The usual annual meeting of the American Fish-culturists' Association was held in New York on the 9th and 10th of February, 1875, at the office of Mr. George Shepard Page, a leading member of the body in question. A large attendance was present from most parts of the country, embracing some of the most accomplished and successful fish-culturists of the United States and Canada. Among the more notable persons present were Hon. Robert B. Roosevelt, president of the association, Mr. A. S. Collins, Seth Green, Fred Mather, Dr. Hudson, and Mr. Pike, of Connecticut, E. A. Brackett, Dr. M. C. Edmunds, B. B. Porter, A. A. Anderson, H. J. Reeder, Rudolph Hessel, and others.

Various communications in reference to practical pisciculture were presented and discussed during the meeting.

On the 11th of February a meeting of the State Fish Commissioners was held at the Fifth Avenue Hotel, called by Professor Baird, the United States Fish Commissioner, the principal object being the consideration of the most important subjects connected with the labors of the State Commissioners. Mr. J. W. Milner, the Assistant Commissioner of Fisheries, read a paper, which was considered, and recommended by the meeting for publication.

OBJECTION TO THE USE OF SUBMERGED NET-WEIRS.

Special attention is called to the propriety of forbidding the use of submerged net-weirs in the waters of Lake Champlain for the capture of whitefish, a custom which, in the opinion of the Commissioners, will inevitably result, in a very few years, in causing the practical destruction of this valuable article of food.

FISHERIES AND SEAL-HUNTING IN THE WHITE SEA AND NORTHERN OCEAN.

Mr. Alexander Schulz, of Russia, has lately communicated to the Geographical Society of Dresden an important paper on the fisheries and seal-hunting in the White Sea and Northern Ocean, of somewhat the same character as his elaborate paper on the fisheries of the Caspian, published at Vienna, to illustrate a collection of specimens exhibited at the Exposition. In his last paper he remarks that most of the fishing villages are situated on the south and southwest shores of the White Sea, but that along the Murmanian coast, which stretches as far as Norway, there are no regular fishing settlements, and only huts and storehouses, unoccupied during the winter. From April to the middle of August, however, about 5000 fishermen repair thither from the shores of the White Sea to take part in the cod-fishery, the annual value of which amounts to about two millions of rubles. The most important fishes of the region are cod, salmon, and herring, which are prepared in various ways for the market. Between July and September many vessels go from the coast villages to Nova Zembla in search of seals, walruses, bears, and a small species of salmon. Dolphins or porpoises are taken in abundance, and there are extensive hunting-grounds.—6 *A*, *October*, 1874, 311.

CLOSE TIME FOR THE CAPTURE OF SEALS.

An attempt has just been made by the governments of Great Britain and Norway to establish a close time for the capture of young and old seals. It has heretofore been the practice of those engaged in this trade to start out in March, and commence the capture immediately. The result is the destruction of large numbers of female seals while their young are still on the ice, and incapable of taking care of themselves; these young also perish, and, in consequence, the present method of capture threatens extermination to the seals, or at least their reduction to such limited numbers as to render them of comparatively little commercial importance. It was originally suggested that the 1st of April be fixed upon as the day for the commencement of the pursuit. It is now proposed, however, that it be the 5th or 6th instead. If the young are captured later than this they are not only of greater commercial value, but also, in the event of the loss of the mother, they are better able to take care of themselves. As to the time of closing the fisheries, it is suggested that this need not be fixed, as after the middle of May the old seals become very wild, and few can be captured, although the 30th of June might be indicated as satisfactory. The Norwegians do not seem inclined to accept the later date of April, and the 3d of April is suggested as a compromise.

BAD CONDITION OF THE HAIR-SEAL FISHERIES.

Frank Buckland gives a report, obtained from Captain Gray, of Peterhead, in regard to the hair-seal fisheries of the North Atlantic during the year 1874. In this he states that the yield has been less than at any previous period, and that unless prompt measures are taken for its restoration the business will become practically worthless. One of the most successful in a fleet of thirty-three steam-vessels obtained but 2600 seals. At a conference with sailing captains, called by the Board of Trade, the opinion was expressed that a close time for seals is absolutely necessary, or they will become exterminated. The time allowed for the destruction of seals it was thought should be from April 5 to May 15, the 25th of March being entirely too early. It is suggested that the fine for a violation of the close time be 2000 pounds sterling. —2 *A, December* 19, 1874, 474.

FISH CONSUMPTION OF WASHINGTON IN 1874.

The report of Mr. C. Ludington, Food Inspector to the Board of Health of the City of Washington, gives a very interesting account of the consumption of animal food in a great city, and it is much to be desired that similar statistics be supplied for such points as New York, Boston, Philadelphia, Baltimore, Cincinnati, Chicago, St. Louis, etc. In respect to fish, it appears that for the market of Washington alone, during twelve months from Sept. 30, 1873, to Sept. 30, 1874, the following numbers were inspected:

Shad	628,637	Sturgeon	919
Herring	6,567,240	Bushels of oysters	569,372
Hickory shad, or tailors	80,841	Number of clams	1,163,000
Bunches of fish	567,291	Number of crabs	297,250

The fish weighed, in the aggregate, about 11,000,000 pounds; and by far the greater proportion were derived from the Potomac River and the lower part of Chesapeake Bay. When we bear in mind the fact that Alexandria, Norfolk, Richmond, and many other places, were supplied from the same storehouse, to say nothing of the immense quantities exported to more distant points, we may realize the importance of the fisheries as bearing upon the question of national economy.

The larger portion, indeed nearly all, of these fish were anadromous species, or such as live for most of the year in the sea and obtain the greater part of their growth there, and run up into fresh water for the purpose of spawning; among them the shad, the alewife, or fresh-water herring, the rock-fish, or striped bass, etc.

According to the tables prepared by Mr. Ludington, the shad supply was about one fourth less than that for 1873; but the herring were nearly double in number. In 1874 there were 2,261,117 pounds more fish inspected than in 1873. In this report the inspector urges very strongly the regulation of the capture of shad and herring in the Potomac River, so that none shall be taken after the first day of June, in any year, until the next regular fishing season, and also that the hauling of the seine be prohibited on Sunday at any time.—*Rept. Wash. Board of Health*, 1874.

EFFECT OF POLLUTED WATER ON FISHES.

Among the various agencies injurious to fishes in fresh-water streams are the waste products from gas-works, the creosote and other similar substances contained therein, even if in very small quantity, having a marked and destructive effect; and even where the percentage is not sufficient to cause death, or apparently to affect the health of the animals, it imparts a disagreeable taste, readily perceptible, especially in the case of oysters and clams, and even of fishes.

An appeal was recently presented by the fishermen of Munich to the government in reference to the admission of gas-water into the River Isar, and its influence upon the fishes of that stream. Professor A. Wagner, an eminent chemist, was instructed to investigate the matter and make a report upon it. His article has lately appeared in the *Bayerisches Industrie- und Gewerbeblatt*, in which he describes a number of his experiments. For this purpose he introduced small fishes into vessels containing well-water, different amounts of gas-water being added. The results were as follows:

In water to which one per cent. of gas refuse was added, the fish put into it became at once very restless, tried to jump out, turned on their backs after they had been in the water one minute, and were dead after the lapse of six minutes. In water containing one half per cent. of gas refuse, fish became at once restless, floated on their backs after five minutes, and died in thirty minutes. In water to which one quarter per cent. of gas refuse had been added, fish became restless after some time, floated on their backs in one hour, and were dead after an hour and a half. In water containing one tenth per cent. of gas-water, the fish remained quiet; one of them showed no change after three hours and a half, but died after the lapse of six hours; no change was noticed in the case of another, a small pike, after seven hours, but it was found dead the next morning.

To reduce the injurious effect, therefore, of gas refuse on fish, Professor Wagner recommends that instead of emptying barrels containing about thirty cwt. of gas-water into the river at once, as hitherto practiced, it should be slowly run into it in a thin stream, so as to effect the running in of the quantity produced during the day in the twenty-four hours, the stream never exceeding five quarts, nor being less than one quart, per minute. By this means these small quantities would at once be diluted to such an extent as to become comparatively harmless, chemical decomposition of their elements in the river-water setting in at the same time, and the injurious influence need no longer be feared.—2 *A*, *Oct.* 17, 1874, 293.

MENHADEN OIL AND GUANO.

The great magnitude of the interest connected with the manufacture of oil and guano from the menhaden has, as in other cases, induced the formation of an association for mutual protection, under the title of "The United States Menhaden Oil and Guano Association." The statistics of capture of menhaden and the manufacture of oil and guano are shown by the following table:

	Barrels.
Number of fish caught during 1874	1,478,634
Number of fish caught during 1873	1,193,100
Making an increase of	285,534
	Tons.
Amount of guano in 1874	50,976
Amount of guano in 1873	36,290
Increase for 1874	14,686
	Gallons.
Quantity of oil manufactured in 1874	3,372,837
Quantity of oil manufactured in 1873	2,214,800
Increase for 1874	1,158,037

The number of barrels, as given above, would be equal to the following number of fish:

Fish caught in 1874	492,878,000
Fish caught in 1873	397,700,000
Increase in 1874 over 1873	95,178,000

The amount of oil on hand at the beginning of the year was 648,000 gallons, and 5200 tons of guano remained unsold. The number of fishermen returned for 1874 was 1567;

the number of men employed at the manufactories, 871; the number of sailing-vessels employed, 283; steamers, 25. There is a capital of $2,500,000 invested in the business, with 64 factories. A market has been found in the West Indies and in England for the guano.

HYBRID FISH.

Dr. L. J. Fitzinger has been prosecuting some experiments upon the bastard forms of *Salmonidæ*, now so extensively cultivated in the fish-breeding establishments of Germany, and which, as is well known, attain to maturity and produce completely formed eggs. However, as the result of a careful series of experiments, he ascertained that, under artificial impregnation, these eggs never develop beyond the period of the formation of the eye specks, after which they speedily perish. The hybrids upon which the experiments were prosecuted were obtained from the female trout (*Trutta lacustris*) and the male saibling (*Salmo salvelinus*), and from the female saibling and the male trout (*Trutta fario*). He thinks that the infertility of the eggs from these hybrids may be considered as an established fact. In the same article reference is made to what is called the Silver trout, or *Salmo Schieffer-Mülleri*, and the opinion expressed that this is a sterile form, but that it is impossible to say from what species it is derived or whether it is constant.

EXPERIMENTS WITH YOUNG MAINE SALMON.

In the winter of 1872–73 a number of eggs of the Maine salmon were presented by the United States to the State of Wisconsin, and hatched out at Waterville by Mr. H. F. Dousman, an experienced fish-culturist of that place. The greater portion of these were distributed by him in various rivers of the state, a few, however, being left in his ponds. On the 2d of December, 1874, in taking out his trout for the purpose of collecting the spawn, he found three salmon in the races, one female and two males. These were all ripe, and he obtained from the female about two hundred eggs, and impregnated them with the milt from the males. These eggs he has placed in a separate inclosure, and proposes to ascertain whether they will hatch out, and, if the young can be reared to maturity, what their character will be. The female was about five inches in length, one of the males eight, and the other seven. Their average weight was about three ounces, which is considerably less than that of the trout with which they were associated.

INCREASE OF ENGLISH FISHES IN TASMANIA.

In illustration of what may be done in the way of multiplying food fishes in new localities, we may refer to the results of experiments made in Tasmania in connection with the English trout and the English perch. In four successive years prior to 1861 attempts were made to introduce these fishes into Tasmania from England, but it was not until December, 1861, that a fifth attempt succeeded. A certain number of live fish having been brought out and placed in ponds expressly built for them by Mr. Allport, other fish were obtained in the following year, from which the immense supply now so extensively distributed throughout Tasmania and Australia have been derived. The present abundance may be estimated from the fact that, in Lake Wendouree, at Ballarat, no less than nine tons were caught during the last season. One fish, three years old, weighed three and a half pounds; another, taken in 1874, weighed four pounds. The parent fish were first brought from England to Tasmania, and afterward from the latter country to Victoria. Five small fishes represent the ancestry of the fish referred to as existing in the last-mentioned country.—*Pr. Zool. and Acclim. Soc. of Tasmania for* 1874, p. 44.

STOCKING THE RIVERS ON THE WEST SIDE OF LAKE CHAMPLAIN BY THE U. S. FISH COMMISSION.

The United States Fish Commission has recently completed a very important undertaking in the interest of the State of New York, in the way of stocking the rivers of the state on the west side of Lake Champlain, especially the Chazy, the Salmon, and the Saranac, with salmon, some 200,000 in number having been hatched out at the establishment of Messrs. Stone & Hooper, at Charlestown, New Hampshire, and planted by Dr. M. C. Edmunds, one of the Fish Commissioners of Vermont.

The entire expense of this enterprise, amounting to nearly four hundred dollars, has been met by the United States.

It is well known that salmon formerly abounded in Lake Champlain and its tributaries on both sides, and, with a view of determining whether the same condition of things can be restored to these waters, this experiment has been made.

DISTRIBUTION OF TROUT EGGS FROM TASMANIA TO THE NEIGHBORING COLONIES.

The Society of Arts refers to an official report in regard to the acclimatization of trout in Tasmania, which states that in 1873 a total distribution of 4050 trout eggs was made from the rivers of that country to the neighboring colonies; 800 of these were sea trout, the rest being those of the brown trout.—23 *A*, *June* 11, 1875, 664.

IMPORTATION OF THE GOURAMI INTO PARIS.

A Paris journal announces the arrival in that city, in November last, of forty-eight gourami fish, sent to M. Carbonnier, the well-known dealer in aquarial supplies, and who has made a specialty of importing fish of this character. This gentleman now has seventy specimens in all, in thriving condition. The fish is warmly recommended for introduction into the hotter parts of the United States, especially South Carolina, Western Florida, and other sections where ice and frost are unknown.

Their special merit consists in their being fresh-water fish, of large size and great excellence of flesh, that feed entirely on vegetable matter, so that if placed in a pond with plenty of aquatic plants around them they will live and thrive without requiring any artificial means.—10 *B*, *Dec.*, 1874, 770.

FRENCH METHOD OF OYSTER CULTURE.

M. Crugny announces in *Les Mondes* that, after ten years of groping in the dark in the treatment of the great oyster banks of France, especially of Arcachon, these have entered upon a career of fertility so prodigious that Arcachon alone will soon be able to furnish oysters for the whole world, and at prices much lower than those which at present prevail. It is well known, according to Crugny, that each oyster produces, every year, spat sufficient to furnish 4,000,000 of young, but that innumerable sources of destruction greatly reduce the yield. At the present time, in the light of more recent experiences, spat is collected on tiles previously coated with a sticky composition, to which it strongly attaches itself; while the slight adherence of this composition to the tile permits the introduction of an instrument which easily detaches the young oyster without injuring it. The spat, when it has acquired the size of a quarter-franc piece, is placed in wooden boxes covered externally with zinc, the upper opening of which is closed by a wire network of close meshes. After the oysters have increased in this inclosure, protected from every external attack, they are placed in large ditches, excavated either by the hand of man or by nature, in which at low tide there is always a sufficient depth of water to protect the young shells against the severities of the winter or the heats of the summer. Thanks to all these precautions, the oyster-culturists in France have lately been able to save a large part of their crop, and can soon, if nothing interfere, furnish excellent oysters at a cheap price.—3 *B*, *Nov.* 26, 1874, 516.

MR. C. G. ATKINS'S EXPERIMENTS ON THE ARTIFICIAL HATCHING OF THE SMELT.

Among the recent novelties in fish-culture may be mentioned the experiments made by Mr. Charles G. Atkins, at his establishment in Bucksport, Me., on the artificial hatching of the eggs of the smelt. It is not a new thing to transport the parent fish from one locality to another, and thus cause their multiplication, but Mr. Atkins is the first actually to take the eggs, impregnate them by artificial means, and bring their hatching to a successful termination. The particular variety treated by him is what is known as the *Belgrade* smelt, a fresh-water and land-locked species found in the Belgrade River, in Maine. It attains a very large size (for a smelt), its weight sometimes amounting to nearly a pound, and with a length of ten or twelve inches; these dimensions being, as the experienced will readily understand, very much larger than the ordinary smelt. The difficulty in hatching the eggs of this fish lies in the fact that they are adhesive, instead of being dry, as in the salmon and shad. They are covered with a tenacious mucus, which causes them to stick to the first object they touch, and prevents their treatment by the ordinary method. Mr. Atkins, however, causes them to drop upon twigs, pieces of cocoa-matting, etc., and then subjects them to the fertilizing influence of the male. He in this way obtained about a hundred thousand from each female, the time of hatching extending over nearly a month. The young are hardy and vigorous, and will probably require five or six days for the absorption of the yolk. Mr. Atkins thinks that the conditions of success in treating the hatching of carp artificially are those which have just been mentioned, and, in addition, a strong current for the hatching and development, together with the avoidance of all jarring.

SETH GREEN'S ARTIFICIAL HATCHING OF STURGEON.

A very important experiment has just been made successfully by Seth Green on the artificial hatching of sturgeon, a subject to which he has had his attention directed for some years, but which he has not been able to carry into actual effect until 1875. No details of his experiment have yet been published; but it is understood that he has found little difficulty in breeding them, and that he has turned many thousands into the Hudson River.

The sturgeon is a very valuable fish, the flesh being not only excellent when fresh, but particularly nice when smoked. The caviare and isinglass obtained from the fish constitute important elements of its value, both of which are now manufactured in various parts of the United States on a large scale.

An incidental effect of the experiments made by Mr. Green will be the policing of the Hudson River, and keeping it free from the shad seines which now prevent the upward movement of the fish. Another season the sturgeon will probably encounter these nets, tearing them to pieces in their passage.

THE NEW WESTMINSTER AQUARIUM.

Among the magnificent aquaria lately started in Europe, that of "The Royal Aquarium and Summer and Winter Gardens" at Westminster, now in process of erection, promises to be the most notable, embracing as it does in its construction the best features of the other establishments and omitting their imperfections. In size, too, and resources, it bids fair to outrank all the others. The building on Tuthill Street is 545 feet long, from 160 to 240 feet broad at the broadest part, and 80 feet where narrowest, the height being from 60 to 80 feet. On the ground-floor is a spacious promenade, and the tanks are placed around half its length on the north side, and nearly the whole of the length of the south side. These are 31 in number: two containing about 40,000 gallons each, one of 12,000, twelve of 4000 gallons each, two more of 1400 gallons, and fourteen each of 270 gallons. In addition there will be twelve others, not for public exhibition, but for reserve or hospital purposes, each containing about 400 gallons. The largest fifteen tanks are of masonry, forming part of the building itself. The smaller ones are of slate. The fronts of all are of plate glass, of which there will be about 2000 square feet one inch thick, and 500 feet half an inch thick, all toughened by De la Bastie's process.

Every water receptacle not made of slate is to be lined with asphalt, and all the pipes are so placed as to be easily accessible for examination for leakages. Beneath the floor of the promenade is an enormous reservoir, looking like three railway tunnels, arched above and below, and holding in all about 700,000 gallons; and from this the water will be pumped into the tanks above at the rate of from 15,000 to 30,000 gallons per hour day and night incessantly. To guard against the stoppage of the current from accidents to the machinery, the steam-engines and boilers are doubled. The boilers are much larger than needed by the steam-engines, as the former will be used also to warm the building in winter. The water in the tanks will take its temperature from that in the reservoir, and always at a mean between that of the surrounding air of summer and winter. There are eight pumps—four for sea and four for fresh water; and these pumps, with all pipes, taps, valves, gratings, and jets, are to be of vulcanite or hard India rubber. Metal in any form would corrode in time and gradually poison the water, which it is proposed to use indefinitely without change, since, singular as it may seem, the longer a large mass of water is used for aquarium purposes the better it appears to be.

The great reservoir is divided into nine compartments, with an arrangement to enable any one or more to be isolated and emptied for examination without wasting any water or interrupting the circulation. This, by reason of its great dimensions, and also by reason of its coolness and darkness and the absence of life in it, will keep the entire aquarium arrangement in good order, since the water will be constantly flowing in and out of it. It will travel a distance of nearly three miles between the beginning and end of its circuit, in the course of which a portion (about one tenth) will be lifted about seven feet, and be made to enter each tank with force through fine jets, which will carry air into the tanks in a finely divided state. The total quantity of water in use, including that in the proposed fountain basins, will be nearly a million gallons, of which about three fourths will be sea-water, to be brought from Brighton in casks by Mr. W. Hudson, at the rate of a railway train of twelve trucks full every day for six months.

Mr. A. Bedborough is the architect, Messrs. Lucas are the builders, Messrs. Leete, Edwards, & Norman furnish the machinery and circulating apparatus, Messrs. Doulton & Co. supply the ornamental tiles. The rock work is furnished by Mr. Wills; Professor R. V. Tuson is the chemist of the establishment, the whole being under the direction of Mr. Lloyd himself, well known from his connection with the Hamburg establishment and others which he has organized. For the proper supply of animals for this and other aquaria, it is contemplated to arrange two traveling aquaria—one for Great Britain and the other for the Continent—to convey living marine animals from the Naples aquarium, where a great variety of species can always be had. According to Mr. Lloyd, the old-fashioned plan of maintaining a proper supply of oxygen for the animals in aquaria, by the introduction of living plants, is practically inapplicable to large establishments, the true theory being that of keeping the water cool and clear, and properly charged with atmospheric air in a large, dark reservoir.

In addition to the aquarial display at Westminster, there will be a picture and fine art gallery, and accommodations for flower shows, etc. Musical entertainments will also be given. Mr. Lloyd protests against the admission of the lung-breathing aquatic animals, such as seals, porpoises, and the like; and he proposes also to exclude all reptiles, birds, and mammals.—15 *A*, *Sept.* 18, 376.

FISH AT GREAT DEPTHS.

For the purpose of illustrating the physical conditions to which fish are exposed at great depths, M. Moreau has subjected them to a pressure of ten atmospheres in a vessel. He finds that by bringing this on gradually the fish do not experience any ill effect, but that on suddenly relaxing the pressure they die rapidly with hemorrhage, the blood becoming spumous. This phenomenon he considers due to the disengagement of the gas which the blood had dissolved in large quantity.—8 *B*, *July* 24, 96.

PISCICULTURAL PRIZES.

Among the prizes recently decreed by the Société d'Acclimatation of Paris, at its annual public session on the 7th of May, was one of five hundred francs to M. Carbonnier for the exhibition of specimens of American *Fundula cyprinodonta*, characterized as being a fish of very excellent flavor. It is difficult to understand that this fish, well known in the United States, is now considered as one of importance, there being so many others of superior size and rapidity of growth that could have been selected. As M. Carbonnier exhibited specimens born in Paris, his prize was doubled, and he received one thousand francs.

On the same occasion a medal of the first class was given to Seth Green—this in addition to the grand gold medal which he received in 1872. This last-mentioned prize was in return for the transmission to Paris during the last year of fertilized eggs of various species of salmonidæ.

The introduction of the California salmon into the Eastern United States has also been considered by the French society a matter of very great economical importance; and although not specially interested at present in the species, they have decreed to Mr. Livingston Stone a second-class medal for his superintendence of the United States breeding establishment, and also similar honors to Mr. G. H. Jerome, one of the Fish Commissioners of Michigan, and to Mr. Crouch, of Jackson, for hatching out and distributing the young of these fish in the St. Joseph, the Kalamazoo, and Grand Rivers.

Special attention is invited by the society to the California fish, and the hope is expressed that it may be ultimately introduced into the tributaries of the Mediterranean, and especially into the Rhone.—10 *B*, *May* 30, 1875, 60.

CHANGE OF WATER IN AQUARIA.

A writer upon marine aquaria remarks that the experience of Mr. Bawins, who has possessed a marine aquarium for ten years, has been that he has not renewed the sea-water contained in it during that period. All that he has done is to add fresh water as the salt water evaporates, the same degree of saltness being invariably maintained. Various species of small sea-weeds and several mollusks thrive without further care; but some species of Actinia raised in the same medium were starved to death in the absence of the owner, who had made a practice of feeding them with worms and even raw meat.—12 *A*, *June* 10, 116.

FRENCH PRIZES FOR AMERICAN FISH.

North America possesses an enviable superiority over most parts of the world in the number and variety of fresh-water fishes capable of being multiplied artificially for the service of mankind, having species corresponding to nearly all those known elsewhere, and several forms entirely peculiar to its own waters. Thus while its wall-eyed pike, or pike-perch, is equivalent to the much-esteemed sandre, the yellow perch to a similar species in Europe, the striped bass, or the rock-fish, to the European bass, it has in the black bass and the large variety of smelt, the trout, whitefish, and the California salmon, forms whose introduction into Europe is very desirable, to say nothing of the shad and alewife.

Recognizing this fact, the authorities of the Paris Société d'Acclimatation have offered prizes of five hundred francs, respectively, for the introduction into France of our common brook-trout, of the Otsego bass, the California salmon, and the black bass, on the condition that the imported fish survived for more than a year. If young fish bred from these parents can be exhibited, then the amount of the prize in each case is to be doubled. The prizes in regard to the trout and black bass were open till the 1st of December, 1875; those for the Otsego bass and California salmon remain open until the 1st of December, 1880. A prize of two hundred and fifty francs was open until the 1st of December, 1875, for the multiplication in France of the American bull-frog, this conditioned with the exhibition of at least twenty-five specimens born in France.—10 *B*, *May* 30, 1875.

FISH-CULTURE IN CHINA.

According to M. Renaud, the method adopted by the Chinese for raising the cyprinoid fishes, such as the carp, tench, etc., is by placing them in large earthen vessels, some hundreds of gallons in capacity, filled with fresh-water plants. When the spawning season arrives, which is known by the disturbance of the water in consequence of the rapid movements of the fish, the eggs, which are deposited on the plants, are removed by means of a skimmer, and placed in the shade in a vessel with a flat bottom and about four inches in depth. The hatching takes place at the end of about eight days, and after the yolk-bag is absorbed, numerous minute embryos of insects, crustaceans, etc., found in stagnant water, are obtained from the surface with gauze nets, which are then washed off in the water containing the young fry. At the end of six months these attain the dimensions of about an inch in length, after which they may be turned into the vessels in which are the larger fish.—10 *B*, *June*, 294.

NEWFOUNDLAND FISHERIES IN 1874–5.

By the report of the Chamber of Commerce of Newfoundland for 1874–5, we learn that the Labrador cod-fishery was of an average catch, and that the Labrador herring-fishery during the fall of 1874 was unusually productive. The seal-fishery, however, was entirely unsatisfactory, with very few exceptions, the sailing-vessels being unsuccessful, owing to the enormous quantity of ice packed on the coast, and the unusually severe weather. The catch by the steamers was better, and the seals were taken in a much more mature condition than those captured last year.

The export of cod-fish for 1874 was very large, having reached the enormous total of 1,609,724 quintals, being a large increase over that of 1873. The present condition of the shore fisheries for the season of 1875 is unsatisfactory, the capelin, the bait used for taking the cod-fish, having remained but a short time, and, when obtained, being but slightly attractive. It is hoped that when the squid come in the fishery will be more successful. Several vessels are now employed exclusively in capturing squid to be furnished to the fishermen, and their operations have been prosecuted to such an extent as to induce some fear of the failure hereafter of the supply of this important animal.

ILLUMINATION FOR ATTRACTING FISH.

Among the articles exhibited at the International Maritime Exhibition at Paris was an arrangement for producing light under water, consisting of a platinum wire placed in a bottle, and ignited by electricity from a bichromate battery. It is said that experiments tried by this apparatus on the coast of France proved very satisfactory, attracting large numbers of fish, sardines especially.

A somewhat similar arrangement was proposed some years ago in the United States, in which, after the fish are brought near enough, a vortex of water is to be produced by a steam-pump, which, in spite of resistance, draws them into a trap, until this becomes entirely full. We have not learned whether any experiments were ever made with such an apparatus.—12 *A*, *Sept.* 2, 388.

MANUFACTURE OF COD-LIVER OIL.

The production of cod-liver oil in the United States and the British Provinces is carried on at present on a very large scale, the greatest amount being prepared at St. Johns, Newfoundland, from its proximity to the great fishing-banks. The process of producing this oil is very simple, consisting in first carefully washing the livers until every trace of gall and foreign matter is removed, after which they are placed, with a little water, in a specially contrived boiler, and heated to a temperature of 112°. The livers swell and finally burst, when the oil contained in them rises to the top, and is at once skimmed off. This portion of the operation must be performed in as short a time as possible, so that the oil may rise and be removed before the livers have time to break up and mingle with it. One cause of the offensive taste and smell that cod-liver oil sometimes exhibits is from the mingling of very minute pieces of the liver with the oil, which afterward putrefy in it. After being skimmed off, the oil is boiled until the water is evaporated.

The next operation is that of filtering, which is continued at least four times, the last filter being of the finest muslin, which extracts all traces of sediment. The resultant liquid, provided the livers were not more than twelve hours old, resembles Sauterne wine in appearance, and is almost entirely devoid of color, taste, and smell.

The usual yield of oil is given as about one gallon to the quintal of livers. Owing to the low temperature at which the oil is extracted, fifteen months is the longest time it will keep sweet and retain its original flavor; after that time various ingredients are mixed with it which preserve it, or rather disguise its rancid taste.

In some localities in America the process of steaming is resorted to, which is supposed to facilitate the operation and improve the product.

OPERATIONS OF THE UNITED STATES FISH COMMISSION IN 1875.

The operations of the United States Fish Commission for the year 1875, so far as the hatching and distributing of shad were concerned, closed at the end of July, after a very successful season. The work was commenced in April, on the Neuse, in North Carolina, and continued subsequently on the Pamunky, the Rappahannock, the Potomac, and the Delaware; but, owing to the extremely small run of shad in these streams, very little was accomplished. With the assistance of the New York State Commission, a small supply of young shad was obtained at Castleton, on the Hudson; but even here the run of shad was very poor, being much below that of previous years. The indifferent luck of the season was, however, changed after commencing operations at Holyoke, on the Connecticut, about the 1st of July, where, under the direction of Mr. James W. Milner, the Assistant Fish Commissioner, a very extensive hatching and distribution was initiated, the work extending satisfactorily throughout the month. Here the entire expense of hatching and distribution was borne by the United States, the agreement made by the United States Commissioner with the fishery authorities of Connecticut and Massachusetts being to put half of all the fish hatched into the Connecticut River, one fourth of this number to be sent up the river to a considerable distance.

The total number of fish hatched at this station was about 3,370,000, of which 2,000,000 were turned loose into the Connecticut, the shipments to other rivers amounting to 1,370,000, those from the Hudson and Delaware being only 625,000. Of the fish sent from the three rivers, 755,000 were placed in the tributaries of the Mississippi, 280,000 in streams that empty directly into the Gulf of Mexico, and 560,000 in rivers (other than the Connecticut) which empty into the Atlantic. The waters of nearly every state east of the Missouri have been benefited by the shipments made during the season. There can be no question that this large and widespread distribution of fish will have a very important bearing upon the solution of the problem of stocking the waters of the United States with useful food fishes. It must be borne in mind that the advantage of the artificial hatching of fish over the natural spawning consists not merely in the ability to plant the fish where it is desired to have them, but also in the much greater success of the work. It is generally estimated that not more than one egg in a thousand (if so many) of those naturally spawned produces a young fish able to provide for itself. In artificial hatching, however, of one thousand eggs taken there is a probability that at least nine hundred, or even more, will reach the above-mentioned stage; so that, instead of counting upon the proceeds of 4,000,000 eggs under ordinary circumstances, we should have those of 3,600,000,000. Included in the number of eggs collected at Holyoke were 400,000 shipped to Germany on the 17th of July, which were placed in a special apparatus for hatching while on the voyage. We regret, however, to learn that the experiment, like that of last year, was unsuccessful, the eggs perishing before reaching their destination.

SALMON IN THE SAN JOAQUIN.

The question of the possibility of cultivating the California salmon in the warm waters of the Eastern United

States has been very satisfactorily answered by a recent communication of Mr. P. B. Redding, one of the Fish Commissioners of California. This gentleman reports that on the 15th of last August salmon commenced running up the San Joaquin River, passing the bridge across that stream, in latitude 36° 30′, longitude 120°, in large numbers, appearing in size and general character identical with the Sacramento fish. At that point they must have passed for one hundred and fifty miles through the San Joaquin Valley, in which the mean temperature of the air at noon, in the shade, for the summer, has been about 104°, the temperature of the water at the surface from 80° to 86°, and that at the bottom from 75° to 80°. The mean depth of the river has been found to be four feet seven and three-eighths inches.

It is very doubtful whether this water temperature is exceeded in any part of the United States; certainly not in any of our larger rivers, nor in such as would be suitable for the existence of the California salmon.

It is well known that the Eastern salmon becomes uncomfortable when the temperature of the water reaches 65°, while a higher degree of temperature drives them back to the sea in search of cooler quarters.

SALMON TRADE OF THE COLUMBIA RIVER.

The salmon trade on the Columbia River during the season of 1875 has been one of remarkable prosperity, the unfavorable indications at the outset not having been continued. Of fourteen canning establishments on the river, twelve were in operation, and put up in all 275,000 cases, each case containing four dozen one-pound cans, the largest number being put up by A. Booth & Co., at Astoria, or 34,000 cases. A large quantity of fish has also been packed in tierces and barrels, the weight of which has not been given.

An important addition has been made to the usual treatment of these fish in the utilization of the heads for the purpose of extracting the oil, about nine thousand gallons having been obtained by Messrs. Watson & Co., of Manhattan, which was put up in five-gallon tin cans. It is probable, too, that the offal generally will all be used ultimately for oil and manure. The prices so far realized for the salmon have been better than in 1874, amounting to from $1 30 to $1 35 per dozen this year, as contrasted with $1 05 per dozen last year.

MARKED SALMON.

It is the custom at the United States salmon-hatching establishment at Bucksport, Maine, under charge of Mr. Charles G. Atkins, after stripping the spawn and milt from the fish, to return them uninjured to the sea. Each fish is, however, generally marked with a platinum tag, so that it can be identified if it return. An extra price is offered to fishermen for any of these tagged salmon. During the present summer no less than seven of the fish so marked in November, 1873, were received by Mr. Atkins. Unfortunately, however, only the wire band remained, the tags having been worn off or destroyed in some manner. These were all females, in good condition, and well provided with spawn.

SALMON IN THE SACRAMENTO RIVER.

The run of salmon in the Sacramento River during the season of 1875 has been something unprecedented, Mr. Livingston Stone, in charge of the United States salmon-hatching station on the M'Cloud River, stating, under date of August 26, that, in a space of about a hundred yards by thirty, five thousand salmon per hour could be seen jumping out of the water. Mr. Stone has actually counted one hundred in a minute, and has seen eighteen spring out of the water at once.

ANIMAL INCRUSTATION ON THE GREAT EASTERN.

Mr. Henry Lee, in *Land and Water*, gives an interesting account of his visit to the *Great Eastern*, for the purpose of obtaining marine animals for the Brighton Aquarium from the ship's bottom, which was about being cleaned of a vast accumulation of organic matter. The principal mass of adherent substances consisted of mussels, forming one dense deposit covering a surface of fifty thousand square feet of iron plates, and in some parts six inches thick. On the basis of an allowance of twelve pounds of mussels to the square foot, which was considered very reasonable, it was estimated that no less than three hundred tons were attached — enough to load two colliery brigs with full cargoes.—2 *A*, *Aug.* 21, 140.

PHYSICAL CONDITION OF THE HERRING-FISHERY.

The Scottish Herring-fishery Board undertook in 1874 a series of experiments in reference to the physical agencies that affect the salmon-fisheries of Scotland, including a determination of the temperature of the sea by means of deep-sea thermometers at the time and place when fishing was going on. Mr. Buchan, secretary of the Meteorological Society, who has recently analyzed these observations, reports that although the returns are not sufficiently full to afford any accurate rule, owing to the lateness of the period before the sea thermometers were ready to be sent to the fishermen, they prove that "during the periods when good or heavy catches were taken, the barometer was in the great majority of cases high and steady, the winds light and moderate, and electrical phenomena wanting; and, on the other hand, when catches were low, the observations often indicated a low barometer, strong winds, unsettled weather, and thunder and lightning." From the complete returns of the daily catch of fish and of the meteorological conditions, inclusive of the temperature of the sea, now obtained, it is anticipated that materials will be collected in three or four years from which most valuable conclusions will be arrived at.

FOOD FOR TROUT.

Dr. Middleton Goldsmith, the well-known Fish Commissioner of Vermont, residing at Rutland, has lately satisfied himself that trout can be readily fed and reared on corn-bread, the experiment having now been conducted by him over a period of several years with perfect success. He thinks that trout are much healthier and of better flavor when thus fed, although they do not grow so fast as when provided with animal food. There are also fewer cases of diseased fish, and they are much less liable to the attacks of the white fungus—which fastens upon any abraded surface, and soon destroys the fish—than when fed upon meat. It is quite probable that this fungus (from which fish in a natural state are generally free, and which is the pest of all fish-raisers, having been known to destroy many thousands of pounds of fish in a single season) may be the result of some unexplained agency or influence of cooked meats such as are usually fed to trout, and allied to scurvy. If, therefore, the change to a vegetable diet will prevent its occurrence, it will be a very important fact.

Dr. Goldsmith advises corn-bread, as being the least expensive, but finds that any other bread will answer.

ELECTRICAL FISH-BAIT.

Among the novelties in the late Paris Maritime Exhibition is an electrical fish-bait. It consists of a wire of platinum placed in a bottle of dark-colored glass, and made luminous by electricity from a bichromate battery. When thrown into the water the light emanating therefrom is said to attract immense numbers of fishes.

UNITED STATES SALMON-HATCHING ESTABLISHMENT.

The operations during the season of 1875 of the United States salmon-hatching establishment on the M'Cloud River, a tributary of the Upper Sacramento, under the direction of Mr. Livingston Stone, have been conducted with great vigor and with wonderful success, upward of 9,000,000 eggs having been obtained, of which 6,210,000 were sent East in good condition. The remainder have been kept in the hatching-house at the camp, to be developed and placed in the Sacramento River.

The eggs were packed in 156 packages, each two feet square by six inches deep; 80,000 eggs were placed in each box, in layers properly separated by damp moss. They were then packed in crates in pairs, surrounded by stuffing of some kind to prevent jarring. Several different substances were used for this purpose, as moss, hay, and ferns, in order to determine which material is best adapted to the purpose.

The total weight of the consignments amounted to over 20,000 pounds. The bulk of the eggs alone, without the packing, was 80 bushels; 150 bushels of moss were required for packing.

So far as heard from, the eggs sent East during the present season have all arrived in good condition, with very trifling loss, the result being more satisfactory in this respect than in any previous year.

It is probable that nearly three times as many young fish will be hatched out and planted in the waters as were procured in 1874. Between two and three millions of eggs still remained at the establishment on the M'Cloud River on the 14th of October, when the shipments were completed, their hatching and planting in the Sacramento being provided for by some public-spirited citizens of California, among them Governor Leland Stanford, Mr. Crocker, and others.

NEW FISH PRODUCT.

In the fishery division of the Danish agricultural display held not long since at Biborg, in Jutland, a new fish product was exhibited by Möller, in the form of fish-sausage. This consisted of finely chopped salted fish, with an addition of pork and spices, and constituted a very acceptable article of food.

REPORT OF THE FISH COMMISSION OF VIRGINIA.

The annual report of the Fish Commission of Virginia, under its new organization, for 1875, has been published. The Commission is now composed of Mr. A. Moseley, of Richmond, Dr. W. B. Robertson, of Lynchburg, and Professor M. C. Ellsey, of Blacksburg, who have been extremely active in the discharge of their duties, although with a very limited appropriation at their command. The report is very creditable to them, and shows a comprehension of the problem to be solved in regard to the protection and multiplication of food fishes in Virginia. As might have been expected, the shad and the striped and black bass received special attention on their part. Much also has been done in regard to the introduction of the California salmon, that fish of the future. They obtained a large number of the eggs from the United States Fish Commission, for which they established two hatching-houses—one at Blacksburg College and the other at the Virginia Military Institute; and they propose to have others hereafter at the University of Charlottesville and at the Hampden School, at Hampden, whenever their funds will permit. The young fish will probably be soon introduced into their new quarters in appropriate streams in Virginia. The Commissioners also did what they could toward propagating the shad, although the season was unfavorable for the fullest measure of success.

INSPECTION OF FISH IN THE WASHINGTON CITY MARKET.

The annual table of the inspection of fish in the Washington city market has just been presented to the Board of Health by Mr. C. Ludington, Inspector of Marine Products. From this we learn that the number of shad inspected amounted to 464,215; of tailors (a species of shad), to 56,430; and of herring, to 1,674,465. The number of "bunches of fish" sold was 557,203; of sturgeon, 1240; the whole of which, reduced to pounds, is equivalent to 7,002,049. Of oysters there were 305,737 bushels; of clams, 1,110,725; of crabs, 446,525.

This table, as compared with that of 1874, exhibits some notable differences. Of shad scarcely more than two thirds as many were marketed as in 1874, and about one half of the number in 1873. Herring showed a still greater diminution, the yield in 1874 having been 6,567,240. The "bunches of fish" were about the same. On the other hand, the yield of sturgeon was much greater, being nearly three times that of 1873, and thirty per cent. more than that of 1874.

The total yield of fish, in pounds, in 1873 was 8,548,851; in 1874 it was 10,827,967, that of 1875 being a very noticeable diminution from the yield of the previous year. Of oysters and clams a considerable less number was marketed in 1875, but a larger number of crabs.

Some idea of the importance of a careful inspection of the fish in the market may be learned from the fact that the value of the fish condemned as unfit for food in 1875 amounted to over $7000; in 1874 to over $10,000.

It may be remarked that by far the greater portion of the fish sold in the Washington city market is derived from the Potomac River and Chesapeake Bay, as may also be said of the oysters, clams, and crabs. The inferiority in the number of shad and herring taken in 1875 is supposed to have been due to the continued cold weather during the spring, which prevented the waters from attaining a temperature such as would invite the expectant fish to enter the rivers from the sea. The yield in the Delaware, the Hudson, and the Connecticut was larger than usual, thus explaining what became of the difference.

SEVENTH ANNUAL REPORT OF THE FISH COMMISSIONERS OF NEW YORK.

The seventh annual report of the Commissioners of Fisheries of the State of New York, transmitted to the Legislature February 1, 1875, contains a great deal that is interesting and useful in connection with the measures for supplying the rivers and lakes of the United States with food fishes. A noteworthy feature of the report consists in the large number of embellishments it contains, such as the New York shad-hatching camp and the method of taking the spawn from the fish; plates representing the black bass, the salmon-trout, the brook-trout, and the true salmon, showing the appearance of some of them at different ages. There is also a plate representing the typical shad-hatching box, as invented by Seth Green.

Under the head of "Shad Hatching," the Commissioners report the hatching and turning into the Hudson River in 1874 of over 5,000,000 young shad; and they announce that the yield of mature shad for the past year has been 100,000, showing a steady increase in the number from year to year. They state that larger hauls were made in the nets last season than have been known for many years, and that the fish have been every where more abundant, this being accompanied by a corresponding fall in price, the prevailing rates being one third of those that had ruled previously. They think, however, that if they could procure a much larger number of spawning shad, they could accelerate the period when the price shall be as low as was ever known in the country, and they attribute their difficulties in procuring these to the great number of stake nets stretched across the river at many points from its mouth up to Albany, which thus impede the movements of the fish. They earnestly urge that a close time be established, of at least from Saturday night until Monday morning, during which no fish shall be taken, and the nets shall be raised, under a very severe penalty.

The shad-hatching season of 1874 commenced on the 18th of May, and terminated on the 1st of July, making a period of about six weeks.

The Commissioners, after a careful consideration of the facts, are decidedly of the opinion that the experiment of introducing shad into the great lakes has been a success, and that there is every reason to believe that when deposited in the rivers the young will mature in the lakes and return to their starting-point.

The distribution of black bass, which has been going on for several years, has been continued during 1874, amounting to 365 in number; of the Oswego bass, 533; while 1279 of other allied species have been sent out. These operations have already resulted in a greatly increased yield in the general fisheries of the state, so that lakes where nothing could be taken but a few years ago now furnish satisfactory fishing to many persons.

In regard to other fish, the Commissioners report the addition of 527,000 whitefish, and 180,000 salmon-trout, with a large number of eggs sent to many parties who desire to make experiments upon them. The Commissioners speak in terms of approbation of the efforts now making on the part of the United States to introduce the California salmon into such waters as are not suited to the species of Maine, and cite several instances where the young have been taken after introduction into the streams of New York, showing surprising vigor and rapidity of growth.

The report contains some reference to the action taken by the Commissioners in regard to the propagation of the grayling, and they think that the addition of this species may be one of some practical importance, as it certainly is a matter of much interest. A considerable portion of the report is devoted to the consideration of the injurious effect of pound nets and other modes of trapping fish, and they strenuously urge the passage of laws to prohibit their use entirely, or at least to regulate their employment at certain seasons and in certain localities. They point particularly to the use of these nets in the great South Bay of Long Island, where, in their opinion, in consequence of the multiplication of nets within the last few years, line fishing has been almost entirely destroyed.

In conclusion, the Commissioners state that, without relaxing their efforts in regard to other fish, they purpose now to devote more attention to hatching and distributing the brook-trout. Their establishment at Caledonia has an almost unlimited capacity, and they think they will be able to supply trout spawn or young trout, in a certain number at least, to almost all applicants, and that in this way a great addition to the food resources of the state may be secured.

GLOUCESTER FISHERIES IN 1875.

The average valuation of fish landed at Gloucester during the year 1875 was as follows: 177,473 quintals of Bank codfish, $998,628; 185,758 quintals of Georges codfish, $1,021,669; 4258 quintals of hake, $12,764; 2349 quintals of cusk, $7047; 9417 quintals of pollock, $32,964; 2,462,864 lbs. of Georges halibut, $172,365; 7,248,423 lbs. of Bank halibut, $507,388; 38,292 bbls. of herring, $153,168. Total, $2,905,994. This does not include the amount of shore fishery.

FISHERIES OF THE ARCTIC REGIONS.

Captain Adams, of the whaler *Arctic*, arrived at Dundee on the 6th of November from the Davis Strait's fishing. From the condition of the wind and sea at Carey Island he believes there must have been a vast extent of open water toward the north, which would permit the British arctic expedition to reach a higher latitude than possibly could have been done at any time within many years past.

FAILURE IN INTRODUCING SALMON AND TROUT.

An attempt has lately been made to convey the fry of trout and salmon from England to Australia by the Peninsular and Oriental Company's steamers, the route of which is by the Suez Canal; but without success. The experiment proceeded satisfactorily until the Red Sea was reached, when the mortality commenced, and on the twentieth day out the whole of the fish were dead.

GROWTH OF OYSTERS IN FRANCE.

A correspondent of *Land and Water* refers to recent operations conducted in France for the multiplication and growth of oysters, remarking that the process of culture is quite different from that in England, and not so expensive. At Arcachon tiles are used, to which the spat attaches itself when floating about the bay. Walls about eighteen inches high are made of the tiles on the mud-banks, which retain the water when the banks are dry at low tide. In these ponds the young oysters are kept after they are taken off the tiles.

At Auray the collectors of spat used are tiles, wooden boards nailed together, and slates. The wood seems to answer admirably well.

At L'Orient the apparatus of cultivation consists of what are called Michel's Patent Concrete Pans. These are about two and a half by one and a half feet, and eight inches deep, retaining the water when the tide is out. The young oysters remain in these pans, and the growth made in one year is very remarkable. The temperature of the water at L'Orient was sixty-eight degrees.

YARMOUTH AQUARIUM.

The new aquarium at Yarmouth, England, it is said, will be completed by June, 1876. Mr. Saville Kent, at present in charge of the Manchester aquarium, has been appointed manager and naturalist of the new establishment.

K. DOMESTIC AND HOUSEHOLD ECONOMY.

TRANSPARENT SOAP.

The most essential condition in the preparation of transparent soap, and one frequently overlooked, is that the soap employed shall be as nearly neutral as possible, as any free fatty acid present separates subsequently in clouds and flakes; while free soda, on the other hand, attracts carbonic acid from the air, forming crystals of carbonate of soda. The transparency of glycerin soap is also said to be improved by the addition of a small quantity of white sirup.—15 *C*, XII., 191.

THE USE OF GAS FOR LIGHT-HOUSES.

The great advantage of employing gas for light-house purposes is stated to consist in the fact that, by a very simple arrangement, the number of burners and the brilliancy of the flame can be increased from its ordinary to an extraordinary brightness, such as to provide for its visibility in all kinds of thick weather, except, of course, that condition of fog which no light, not even the sunlight, can penetrate. In a fixed light apparatus, of any size, there is no occasion to alter the existing lenses if we wish to introduce the use of gas instead of oil; but in some lanterns it may be necessary to provide for additional ventilation. The cost of gas-light is said to be less than that of oil, while the photometric value of the flame of gas is largely superior to that of any kind of oil. When the "fog-power" of the gas-light is turned on, the cost of the gas per hour is greater; but taking the average of a year's consumption, at several light-houses, it appears that there is an actual saving of about $300 per year by the use of gas. A very simple apparatus effects an automatic intermission in the light, which not only saves somewhat in the consumption of gas, but acts as a means of distinguishing one light-house from another, precisely as is at present brought about by the introduction of the flashing system. A gas-light of the first order, employing Mr. Wigham's gas-burners of 108 jets, would, if fixed, be equal to 70,000 standard candles; but, if revolving, be equal to 873,000 candles.—*Elliot's Light-house System*, p. 169.

PRICE OF BURNING-GAS.

The following figures show the net price of illuminating-gas throughout the United States in 1875, upon the authority of the Washington, D. C., Gaslight Company:

1.	Maine	$3 87
2.	New Hampshire	3 96
3.	Vermont	4 80
4.	Massachusetts	3 86
5.	Rhode Island	3 35
6.	Connecticut	4 03
7.	New York	3 88
8.	New Jersey	3 80
9.	Pennsylvania	3 46
10.	Delaware	3 95
11.	Maryland	3 59
12.	District of Columbia	3 16
13.	Virginia	3 89
14.	West Virginia	3 11
15.	North Carolina	6 67
16.	South Carolina	3 80
17.	Georgia	5 07
18.	Florida	8 00
19.	Alabama	4 83
20.	Mississippi	$5 25
21.	Wisconsin	3 87
22.	Michigan	3 43
23.	Ohio	3 32
24.	Indiana	3 54
25.	Illinois	3 87
26.	Kentucky	3 92
27.	Tennessee	4 06
28.	Minnesota	4 31
29.	Iowa	4 52
30.	Missouri	3 95
31.	Arkansas	5 00
32.	Louisiana	4 50
33.	Texas	5 75
34.	Kansas	4 55
35.	Colorado	5 00
36.	Utah	4 00
37.	California	6 11

Total average net price of gas in the United States, $4 32½ per 1000 cubic feet.

A NEW LIGHT.

According to *The Athenæum*, Mr. Spiller has succeeded in producing a light far better than that from nitro-oxide and the bisulphide of carbon, and free from its dangers. This is accomplished by dropping small pieces of brimstone into fused saltpetre, in a glass tube.—15 *A*, *Jan.* 30, 1875, 166.

TREATMENT OF NEW WOODEN UTENSILS, ETC.

Wooden vessels for containing articles of food, wine, etc., also wooden vessels for culinary purposes, can be rendered fit for immediate use, as to the removal of the unpleasant extractive matters, by treatment with a solution of washing-soda. Thus an ordinary barrel should be filled half full of water, and a solution of about two pounds of soda in as much water as will dissolve it, then headed, and the liquids thoroughly mixed by shaking the barrel, which should then be filled to the bung with water, and allowed to remain for from twelve to fourteen days; then, after withdrawing the discolored liquid, it should be well rinsed and filled with pure water and allowed to remain several days, when it will be fit for use. Other wooden utensils may be treated with a similar solution of soda.—8 *C*, *Nov.* 26, 1874, 422.

LAMP FOR BURNING NITRIC OXIDE GAS.

The brilliancy of the light produced by the combustion of nitric oxide gas, after mixture with a few drops of sulphide of carbon, has been known for some time, and its application to photographic purposes suggested; but it is not until recently that Messrs. Delachanal and Mermet have constructed an apparatus by which it can be made practically available. They use a lamp made of a pint bottle, having two openings through the cork, and filled with fragments of some porous substance, as sponge, coke, or pumice, for the purpose of imbibing the sulphide of carbon. A tube, reaching within one fourth of an inch of the bottom, passes through one opening in the cork, and a larger one through the other opening. This is about eight inches long, and may be of glass or metal, and is closely packed around with iron-scale. The object, like that of the gauze in the safety-lamp, is to prevent the return of the flame into the bottle, and its consequent explosion. The nitric oxide gas is passed into the bottle through the first-mentioned tube, and the gaseous mixture is conducted by a rubber tube to a kind of Bunsen burner, the air-holes of which are closed, and which is furnished with a small conical valve to regulate the flow of gas. This burner is also filled with iron-scale. The nitric oxide gas is produced in the cold by Sainte-Claire Deville's method, by the action of a mixture of nitric and sulphuric acids upon metallic iron. With an apparatus of quite moderate dimensions a dazzling flame, not less than ten inches in height, can be obtained, abundantly sufficient for the purposes of photographic work. It has been estimated that the photographic power of the lamp is superior to that of magnesium, is twice as great as that of the oxyhydrogen light, and three times as great as that of the electric light. Furthermore, the flame is absolutely steady, and there is no danger of its sudden extinction, as with magnesium; and the eye can sustain its brilliance without being affected. Its cost is much less than that of either of the other lights.—1 *D*, *Dec.*, 1874, 381.

NITRIC OXIDE-BISULPHIDE OF CARBON LAMP FOR PHOTOGRAPHIC USE.

A lamp of the following construction, patented by Sell, in England, is said to afford a light very rich in the highly refrangible rays. Photographs have been taken by means of it, with a comparatively short exposure, which are said to be all that can be desired as to the distribution of light and shade. A small spherical glass vessel, filled with bisulphide of carbon, is supplied with a wick, by which it is fed to an ordinary Wild and Wessel burner, through the centre of which nitric oxide is admitted from a gasometer by means of a tube bent at right angles. This globe is inclosed in a larger one of glass, filled with cold water, to cool the bisulphide. Upon lighting the bisulphide, which can be done without danger, and then regulating the flow of nitric oxide and the height of the wick, a beautiful white light of great intensity may be produced.—14 *C*, CCXV., 1875, 384.

MERRIMAN'S WATER-PROOF LIFE-SAVING DRESS.

The following description is given of this invention, the useful character of which has been so admirably tested by Captain Boynton in his recent trial trips in the English Channel. The dress is composed of two principal parts: the upper portion consists of the shirt or jacket, a head-piece, sleeves and gloves, all in one piece, and made of rubber cloth or other water-proof materials. The lower portion is composed of pantaloons and boots of similar material, and also in one piece. The front of the head-piece, corresponding with the face of the wearer, is made highly elastic, and is provided with an aperture of suitable size to expose the eyes, nose, and mouth. The top, back, and sides of the head-piece are made double, forming a cavity for the purpose of admitting of expansion by inflation. The effect of this inflation is not only to support the head when in the water, but also to draw the elastic edges of the aperture tight about the face, thus preventing the ingress of water to the interior of the dress. The back and front of the shirt are also double, the cavity in the back extending upward over the back of the neck to the head. The pantaloons are also double from the waist to the knees, forming cavities front and back for inflation. All these cavities are provided with flexible tubes, long enough to reach the mouth of the wearer, and have suitable valves and stop-cocks. By means of these tubes the several parts of the dress may be inflated to any desired degree. At the upper edge of the pantaloons is fastened a rigid hoop, over which is stretched the lower edge of the shirt, and secured water-tight by means of a waist-belt drawn firmly all around. By dividing the dress into two parts, which can be readily united without water-leakage, it can be adjusted by the wearer in a short time and inflated without aid from others. Besides its buoyancy, a special advantage is claimed for the dress from the fact that the air cavities surround the vital portions of the body, and protect it from being chilled by long exposure in the water.

NEW LUMINOUS MIXTURE.

In Paris, the watchmen in all magazines where inflammable or explosive materials are stored are said to use for purposes of illumination a light prepared according to the following method: A clean glass phial of oblong shape is taken and filled with boiling olive-oil to about one third of its volume; into this is dropped a piece of phosphorus about the size of a pea, upon which the phial is tightly closed with a cork. When it is required for use, the cork is removed, the air is allowed to enter, and the phial is recorked. The empty space above the liquid will then be found to have become luminous, the intensity of the luminosity being about equal to that obtained from an ordinary lamp. As soon as the light becomes feeble, it can be restored by opening the phial and permitting the entrance of a fresh supply of air.

PEROXIDE OF HYDROGEN FOR CHANGING BLACK HAIR TO A GOLDEN YELLOW.

Professor Schrötter, of Vienna, examined carefully the high-priced cosmetic recently introduced by Thiellay, of London, for changing the color of black hair to a golden yellow. He recognized in it simply a dilute peroxide of hydrogen, prepared with well-water, and which owes its permanence to the great degree of dilution and the presence of a small quantity of free acid, most probably nitric acid.—9 *C, December*, 1874, 183.

DUST-SPECTACLES FOR THE PROTECTION OF THE EYES IN VARIOUS OCCUPATIONS.

Spectacle frames, furnished with fine wire gauze instead of glass, carefully fitted to the eye, and fastened to the head by a gum band, have been found by Kühn to answer perfectly for the protection of the eyes from dust, solid particles, etc., in various occupations, as threshing, stone-cutting, etc., while they at the same time permit the necessary access of air to the eye, and produce no inconvenience whatever to the wearer.—15 *C*, XVII, 1874, 266.

PRESERVATION OF MEAT, VEGETABLES, ETC., BY ACETATE OF AMMONIA.

According to an English patent, fresh meat, fish, vegetables, etc., are preserved by immersing them in a more or less concentrated solution of acetate of ammonia, and allowing them to dry in the air. If the articles are to be preserved for months or years, they are packed in cans or casks filled with a solution of the salt. The boiling, roasting, etc., readily expels the acetate, and the articles are said to be free from the sweetish taste which acetate of soda imparts.—5 *C*, L., 1874, 400.

PREVENTING THE CURDLING OF MILK BY OIL OF MUSTARD.

The observation of Schalbe, that the addition of a single drop of oil of mustard to 30 grains of milk will prevent its curdling, for weeks, has been fully confirmed by Vogel in exhaustive comparative experiments with fresh milk, with and without oil of mustard, including the determination, from time to time, of the amount of lactic acid present; from which it also appears that this effect of oil of mustard is due to a retarding action upon the formation of lactic acid, its formation being also almost entirely prevented during the first eleven days, and the amount present fourteen days later being only one seventh of that in milk not so treated. Oil of bitter almonds and oil of cinnamon were found to have a similar effect, but far less in degree; while oil of turpentine, oil of cloves, benzine, carbolic acid, bisulphide of carbon, and sulphureted hydrogen were almost without effect, at least when used in the proportion given for oil of mustard. The additional statement, by Schalbe, that casein was converted into albumen by the addition of oil of mustard, and the suggestion that a cheap method for the manufacture of albumen might be based upon this fact, were not fully sustained by the experiments of Vogel, since the milk thus treated did not always coagulate on boiling.—5 *C*, XLVII., 1874, 375.

CONVENIENT PREPARATION OF CARBONATED WATER.

An ordinary siphon-bottle is employed by Gawalouski, of Prague, instead of the usual Liebig's apparatus, by placing in it, when filled with water, a small tin tube closed with a screw cap, and supplied near the top with several holes about one tenth of an inch wide, and charged, for a two-quart bottle, by placing in it 240 grains of bicarbonate of soda, and upon it a small perforated tin disk, and then 210 grains of tartaric acid. The water passing into the tube causes the development of carbonic acid.—14 *C*, CCXIII., 1874, 402.

CHEAP PREPARATION OF GOOD VINEGAR.

Place an iron-bound oak or beech cask, supplied with a hole half an inch in diameter directly above the spigot, and about one and a half inches below the bung stave, in a cellar that is close and warm in winter, or in some place of similar temperature; first, fill it up to the air-hole with about four gallons of good vinegar (free, however, from purified wood-vinegar, which hinders the formation of vinegar), and allow it to remain for fifteen days, until the wood is thoroughly saturated with it; then draw off from one to one and a half gallons into a second cask, and replace it with as much water, to which a pint of alcohol, free from fusel-oil, has been added. After two or three weeks, again draw off one and a half gallons into the second cask, and replace it in like manner with boiling water and alcohol, and repeat this operation every two weeks. To render the resemblance to wine-vinegar perfect it is only necessary to dissolve some pure tartar in it, and to color it with burnt sugar.—34 *C*, XXI., 1874, 163.

METHOD OF DISTINGUISHING IMPREGNATED EGGS.

A method of distinguishing impregnated eggs from those that are unfertile consists, according to M. Sauvadon, in the use of a tube of pasteboard or of rubber, eight to twelve inches long, and of the diameter of the eggs, through which these are to be examined on the third or fourth day of incubation. They are to be taken, one by one, between the finger and thumb, and held in one end of the tube, which is directed toward the sun, while the eye is applied to the other end. In this way any bad eggs can be easily detected. The good eggs are to be restored to the nest, and at the end of five days, if development is taking place, the fibres of the chicken can easily be perceived through the illuminated shell, and, indeed, the process of development readily followed. This method is, of course, extremely difficult, if not impossible, with eggs that have a colored shell, like those of the pheasant, etc.—3 *B*, *October* 15, 1874, 243.

THE SMOKING AND KEEPING OF SMOKED MEAT.

The following suggestions are among those made by Professor Nessler in regard to the preservation of meat. The keeping qualities of smoked meat do not depend upon the amount of smoking, but upon the uniform and proper drying of the meat. Smoke of high temperature, moisture, and the condensation of water upon the meat are all injurious in smoking meat. With hot, dry smoke the surface is dried too rapidly; a crust, filled with cracks, is formed, and the fat may partially liquefy, and the drying of the interior of the meat be hindered. Bacon is often met with that is brown to the depth of an inch, or even more, simply because it was too warm, or at times moist (sweat), either during the smoking or the subsequent storing. It is doubtless of considerable advantage to roll the meat, on its removal from the salt, before smoking, in sawdust or bran, or to strew it with them, since the crust formed in smoking will not be so thick, and if moisture condenses upon the meat (sweating) it remains in the bran or sawdust, and the brown coloring matter of the smoke does not penetrate the meat. The bran, etc., can easily be removed before using the meat. Warmth, of itself, is not regarded as injurious to smoked meat if moisture is absent and the air is not too confined. In Greece meat is preserved in the shade of trees, in an airy place, rather than in cellars, although the latter are much cooler, because they are at the same time much damper. If a cellar is not very dry, smoked meat will soon mould in it, even if covered with sawdust, ashes, charcoal, etc. A warm room is also preferable, for the preservation of smoked meat, to such as are liable to great variations in temperature, since in the latter moisture is apt to condense upon it. By far the best place, in most cases, for keeping smoked meat is a suitable smokehouse, in which it remains dry, without drying out entirely, as it does when hung in a chimney.—28 *C*, *July*, 1874, 67.

NEW METHOD OF PRESERVING MEAT.

A new method for the preservation of meat, by keeping it in a cool, dry chamber, has been communicated to the French Academy by M. Tellier, well known as the inventor of very efficient ice-producing machinery. His new device consists in the employment of methylic ether, a substance that is gaseous at ordinary temperatures and atmospheric pressure, but which can be reduced to a fluid by a pressure of eight atmospheres. The methylic ether is condensed, and then allowed to expand in contact with metal compartments containing a solution of chloride of calcium, which it reduces to a low temperature. Air is blown through this apparatus, its moisture is deposited as hoar-frost on the metal, and it passes in a dry and cold state to the chamber in which the meat is placed. It is found that the flavor of the meat is not injured by retention in this situation for forty to forty-five days, although it is said to acquire a greasy taste after that period.—13 *A*, *November* 14, 1874, 540.

PRESERVATION OF COOKED MEAT.

Experiments were made by Broxner for the preservation of cooked meat, by cooking 17½ ounces of beef for two hours, by which operation it lost three fifths of its weight, and then squeezing it into a beaker, after cutting it into two pieces, so that it was completely surrounded by a gravy made by browning well 3½ ounces of flour with as much beef-tallow, salting it moderately, and then adding the juice obtained in cooking the meat, mixed with a solution of 60 grains of gelatin in vinegar. In a few hours the whole mass became firm, and the beaker-glass was loosely covered with paper and placed at the closed window of a low attic room. After ten weeks it was found entirely unchanged in consistency, color, odor, or flavor; and tasted, prepared with the gravy, like freshly cooked meat, although the lowest temperature of the room during the whole period was 45½°, and soiled clothing, fruit, etc., had been kept in the same room. He recommends the process for army use.—28 *C*, *June*, 1874, 468.

PATENT COOLING APPARATUS FOR LIQUIDS.

The following apparatus for cooling water, wine, milk, beer, etc., has been patented in Vienna, and is claimed to be the most efficient and convenient, and at the same time the cheapest. It consists simply of a tube, most conveniently made of tin, with a tight-fitting cover, which is rapidly packed, by aid of a wooden stamper, with pounded ice and salt, either mixed or in alternate layers; this is to be plunged into the liquid that is to be kept cool.—5 *C*, XXXVIII., 1874, 303.

REMOVAL OF DRY PUTTY.

According to an English journal, the difficulty of removing hard putty from a window-sash can be obviated with great readiness by simply applying a piece of heated metal, such as a soldering-iron or other similar implement. When heated (but not red-hot) the iron is to be passed slowly over the putty, thereby rendering the latter so soft that it will part from the wood very readily.—18 *A*, *August* 18, 1874, 601.

PASTEUR'S PROCESS WITH WINE AND BEER.

The supposition that wine treated according to Pasteur's method ceased to be liable to deterioration, even with access of organic spores, because the matter necessary for vegetable growth was separated from the liquid in the operation, was not substantiated by the experiments of Nessler, who found that such wine when exposed to the air exhibited acetous vegetation, in consequence of which vinegar was formed. Absolute exclusion of air is therefore necessary for the complete preservation of wine so treated. Application of the process has also been made, with the most satisfactory results, at

Marseilles, to the preservation of beer in bottles, by heating thirty minutes in a water-bath at 115° to 118½°, and then allowing it to cool rapidly. The taste is rendered somewhat milder by the operation, but with storage this effect ceases to be noticeable. When bottled with carbonic acid, and well corked, it is very effervescent. To preserve it a long time, the temperature should be higher, ranging between 115° and 130°, and it is even well to repeat the heating after several months.—5 *C*, XV., 1874, 115.

GLYCERIN AS AN ILLUMINANT.

Pure glycerin, it is said, may be burned in any lamp so arranged that the wick shall not be elevated above the surface of the liquid, since the sirupy consistence of the material prevents it from ascending an elevated wick. The flame is, like that of alcohol, almost colorless. The ready miscibility, however, of this substance with others has given rise to a number of experiments to determine whether the flame could not be colored with foreign substances. The results of these experiments are said to have been quite satisfactory. By introducing into the glycerin substances rich in carbon, it appears that the flame is rendered suitable for illuminating purposes. It is possible, in view of the cheapness of this material, and its non-volatility save at a high temperature, that this property may find extensive application.

IMPROVED REFRIGERATORS.

An important improvement seems to have been made in reference to the preservation of meat and other food in the inventions of M. Kellier, who demonstrates by actual experiments that methylic ether can be so employed to produce cold as to assure the transportation of viands to very great distances without suffering from the atmospheric temperature. The ordinary refrigerators constructed by his system are said to have preserved meats for two months with perfect freshness. Very suggestive is the construction of a cistern as employed by him for the preservation of viands in every household. This cistern replaces the ordinary movable refrigerator, and is simply a well, the temperature of which is kept very low, and into which the viands to be preserved are lowered by a proper frame suspended from a pulley. The mouth of the cistern is then closed, and the accumulation of water at its bottom is removed by a small force-pump.—13 *B*, III., 180.

NEW MODE OF MAKING BREAD.

Cecil proposes the following process for making bread: After washing the grain well with water, and removing the empty shells, it is hulled by means of a revolving cylinder, with roughened interior, and then soaked for from six to eight hours in a thin, sour paste at 77°; then mashed with rollers, and converted into dough, with the addition of salt and water, which is baked as usual.—14 *C*, CCXVI., 1875, 94.

CLARIFYING AND REMOVING FUSEL-OIL FROM LIQUORS.

Liquors prepared by the following method, patented by Plattner, are said to surpass those of France and Holland in fineness and flavor, as they are altogether free from fusel-oil, and possess a peculiar brilliancy. After the digestion of the ingredients necessary for any particular liquor with potato whisky is finished, the liquid is sweetened with crushed sugar and strained, and one ounce of pure starch, half an ounce of very finely powdered prepared albumen, and half an ounce of milk-sugar are added for every two gallons, and the whole mass is well shaken several times, and then allowed to rest for twenty-four hours, when it will be found beautifully cleared, without filtration. — 18 *C*, *May* 5, 1875, 287.

BOHLKEN'S WASHING-MACHINE.

This machine is highly recommended by a German journal, and acts by squeezing rather than rubbing the clothes. It consists essentially of a cylindrical vessel, which is fitted in a frame in such a way that it can be fixed in a vertical or horizontal position at pleasure, and the whole frame can be rotated by means of a crank. The cover can be fitted on it water-tight, with rubber bands and screw clamps, and a heavy zinc cylinder, of nearly the same height but smaller in diameter, is placed within it, but not fastened. The clothes, previously soaped and soaked and boiled, are packed in the vessel in a vertical position, rather loosely, around the zinc cylinder, and it is then filled with boiling soap-suds, and the cover fastened upon it. It is then turned into a horizontal position and rotated for fifteen minutes, part of the time to the right and part to the left. The zinc cylinder is thus rolled upon the clothes, and operates by pressure, and not by friction.—5 *C*, XIV., 1875, 108.

A NEW SUBSTITUTE FOR COFFEE (SACCA COFFEE).

Lehfeld, of Hamburg, has introduced into the market an article intended to be added to ordinary roasted coffee, prepared from the pulp of the berries and the membranes surrounding the beans. It is claimed that while it is much cheaper than coffee, it imparts a fuller and stronger flavor to the beverage, and exercises a preservative effect upon the aroma and other qualities of the coffee, when ground with it, so that it can be kept without deterioration.—6 *C*, *May* 13, 1875, 188.

IMPROVED DWELLINGS, AND THEIR EFFECT ON HEALTH AND MORALS.

Mr. Charles Gotliff, in a paper read before the Statistical Society of London, states that in 1841 his attention was first turned to the subject of the importance of the improvement of dwellings occupied by the laboring classes. On the fifteenth of September in that year an association was formed for the purpose of providing the laboring men with an increase of the comforts and conveniences of life, with full compensation to the capitalist. During the four subsequent years the stock of this association had been taken up to the extent of $100,000. Other societies were also formed for the same purpose, and at the present time 6838 improved dwellings, capable of containing a population of 32,435 persons, have been erected in London by these agencies. As regards the advantages of these habitations, Mr. Gotliff, from personal knowledge and exact inquiry, finds that in the case of the 1060 families accommodated by the Metropolitan Association of London, the rate of mortality during the past eight years has not exceeded 14 per thousand. This diminished death-rate is shown to be accompanied with a very small proportional number of deaths from zymotic and developmental diseases and from violence. The death-rate is even lower in these improved houses than in those country districts with which they can be compared. That the low death-rate does not follow from the specially favorable ages of the inmates is shown by the results of the census taken in December last, which shows that in these houses, out of every 1000 inmates, 330 were under and 670 were above ten years of age. On the average, therefore, the inmates were younger than in the population of London generally; since in that city 237 per thousand are under ten years old. If we compare the death-rate of children under ten years old in these model houses with the death-rate of children under ten years old in London generally, we find that it is 24 per thousand in the former, and 48 per thousand in the latter. In fact, the figures show that the population of the model houses is much more healthy than that of the mixed population of London. There is therefore a saving of disease as well as a decrease of deaths; and the advantage conferred upon the inmates, in the shape both of economy of time and the economy of expense, must be very considerable. In these houses the average population is at least four times more to the acre than in the most densely populated parts of London, forming an irresistible argument in favor of the increase and extension of this class of buildings.

But besides this great decrease in the rate of mortality and disease, and the increase in the density of the population, a great check seems to be given to immorality and crime. Indeed, the improved dwellings of the Metropolitan Association, in the facilities they offer for the detection of crime, actually tend to its discouragement and suppression. There are twelve sets of dwellings in different parts of the metropolis, accommodating in all 5300 persons. At each of these points a superintendent and a laborer reside, which officers, in performing their duties, become acquainted with the tenants, their occupations and pursuits, and are instrumental in speedily detecting and removing any bad characters. About twenty years ago, in one of the dwellings of the association, a working distiller established himself with an illicit still. The rent was regularly brought down to the collector, to prevent him seeing inside of the door of the tenanted rooms, and all went on most satisfactorily until the occupant of one of the basements of the dwelling stated his suspicions to the collector that there was at times a strong smell of mash from the drains. This led to inquiries and an inspection of the premises, when the still was found. The experience of the Metropolitan Association is that the ground-rents of cottages in the country are three and a half pence per family per week, while those of London average eight pence per family per week. Cottages in the country can be constructed at £34 per room, while the construction in London costs £36 per room.

RENEWING WRINKLED SILK.

It is said that silk which has become wrinkled may be made to appear like new by sponging the surface with a weak solution of gum arabic or white glue, and ironing on the wrong side.—18 *A*, *May* 21, 1875, 242.

WASHING WOOLEN CLOTHING.

It has been found on trial that woolen articles treated by the following method, suggested by Dr. Tillmann, do not shrink, and remain unchanged in color. The garments are to be soaked for several hours in a warm, moderately concentrated solution of soda, to which about half a tumbler of ammonia water has been added, more or less, according to the quantity of clothing. They are then to be washed out after the addition of some warm water, and rinsed in fresh water. The same result may be reached by adding a tumbler of ammonia water to a small tub of water, soaking the articles for half an hour in this, and then rinsing them in pure water.—5 *C*, IV., 1875, 32.

AUSTRALIAN METHOD OF OBTAINING COOL WATER.

A simple method of obtaining cool water, practiced very extensively in Australia, seems worthy of introduction into the United States, in localities where ice is not readily procurable. This consists in the use of a large bucket, made of sail-cloth or stout canvas (somewhat like that used for fire buckets), about four feet high and ten inches in diameter. A thick piece of flannel stretched across the top serves as a strainer, and an open cock, a siphon, or some similar arrangement, answers to draw the water. This is to be suspended in the shade, under a tree or elsewhere, where the constant evaporation, intensified by any passing breeze, brings about a temperature very appreciably lower than that of the surrounding air.—1 *B*, *May* 10, 1875, 93.

METHOD OF PRESERVING EGGS.

Professor Sacc now announces that by far the best method of preserving eggs for an indefinite length of time consists in coating them with paraffin, of which one pound will answer for fifteen hundred eggs. After being thus treated they do not experience any loss in weight, and will remain unchanged for several months. It is essential, however, that the eggs be perfectly fresh, as, should decomposition have commenced, the operation will not prevent its continuance.—1 *B*, *May* 16, 1875, 94.

PREVENTING THE BURSTING OF WATER-PIPES BY FROST.

An ingenious method of preventing water-pipes from being burst by frost has lately been patented in England, and consists in passing through the pipes an India-rubber tube of such diameter that the cavity inside it is little more than equal to the increase in the volume of water by freezing. The result is that when the water freezes it compresses the rubber tube, and thus, having the space required in expansion, all danger of bursting the pipe itself is averted. Of course when the ice melts the rubber expands again. The air is supplied from a reservoir, which is acted upon by the water pressure, so as, automatically, to put the air tube under an exactly corresponding degree of tension. By heating the air in the tube the water in the pipes can be thawed. This application is peculiarly useful in the case of water-closets, and in preventing the supply of cold water to engine boilers from being interrupted by frost.—3 *A*, *May* 2, 1874, 557.

WASHING MUSLIN, CAMBRIC, FRENCH LAWN, ETC.

The articles, after having been well soaked in soft water, are to be rubbed in the direction of the threads (without displacing them) with cakes or balls formed from a mass obtained by boiling and skimming one pound of soap, half an ounce of alum, and one ounce of carbonate of potash. After this they are squeezed out, and the operation is repeated several times.

They are next rinsed repeatedly in clear water (since adhering particles of soap will render them yellow); and are finally rinsed in pure water, to which a few drops of tincture of indigo have been added, after which they are again squeezed out, clapped, and dried in the shade.—34 *C*, XVI., 1874, 128.

BEAUTIFUL ORNAMENT FOR ROOMS.

A very ornamental object may be made of a pine cone, by laying it on a stove until the scales are fully open, then filling the spaces with equal parts of sand and grass seed, and hanging it in a dark room for a week with the lower half immersed in a vessel of water. On exposure to light the seeds will germinate rapidly, and produce a luxuriant growth. When hung up in a window subsequently, it should be watered daily with lukewarm water.—9 *C*, *June*, 1874, 89.

EXTRACT OF MEAT IN BREAD.

According to the Abbé Moigno, the experiment of introducing the extract of meat into bread and into vegetable soups, in the various hospitals and naval establishments of Paris, has proved an entire success, and more than vindicates the claims made for it as a nutrient in cases of sickness.—3 *B*, *April* 2, 1874, 625.

ARTIFICIAL VANILLA.

According to Dr. Hoffman, a crystalline substance growing between the wood and the bark of the fir, named coniferine, when acted upon by oxidizing agents, is converted into vanilline, and is said to be undistinguishable in general character from the vanilla of commerce. It is suggested that if the transformation can be effected cheaply, and the result be as efficient as claimed, the trade in the vanilla bean will measurably cease after a time.—18 *A*, *April* 3, 1874, 64.

YAUPON TEA.

A well-known beverage used by the earlier inhabitants of the United States, and, indeed, by the aborigines of the continent, was that prepared from yaupon leaves (*Ilex cassine*), this forming with the aborigines not only a part of the daily household drink, but, mixed with other substances, being largely employed at religious festivals. A recent analysis by Smith shows that it contains a great variety of substances, including only a small percentage of théine. In this respect it is about equal to the maté, or Paraguay tea, but far below coffee and tea in its percentage of valuable ingredients.—17 *A*, *September* 1, 1874, 132.

COVER FOR WATER-COOLERS.

A cylindrical cover of wool felt, or similar material, having a wooden top, with a handle attached, the whole covered externally and internally with flannel and coated with varnish or shellac, is made to slip over the vessel to be kept cool. A rubber ring around the open bottom serves to adjust the cover to any inequalities of the vessel.—13 *C*, *February* 15, 1874, 271.

RENDERING FADED MANUSCRIPT LEGIBLE.

According to the *Revue Industrielle* the best method of rendering faded manuscript legible consists in moistening the paper first with water, and then dipping it in a solution of sulphohydrate of ammonia. The ink is said to reappear immediately, becoming very distinct, and remaining permanent on parchment. Certain parchments treated in this way ten years ago still maintain their legibility. This result is due to the fact that, by the action of sulphohydrate of ammonia, the iron which enters into the composition of the ink is transformed into a very black sulphuret.—13 *B*, *July* 31, 1874, 143.

EFFECT OF WASHING UPON VEGETABLES.

The peculiar flavor of all vegetables is affected by washing, but that of the kinds used for salads is especially impaired by water. These should, therefore, never be washed unless necessary, and then only immediately before preparation for the table, and as rapidly as possible, all the water being removed by shaking or whirling in a net or colander.—9 *C*, *September*, 1874, 134.

L. MECHANICS AND ENGINEERING.

PIG-IRON PRODUCTION IN THE UNITED STATES IN 1874.

From the long-expected statement of the Secretary of the American Iron and Steel Association, which has just appeared in the *Bulletin*, we are enabled to give the following official facts and figures concerning the production of pig-iron in the United States for the year 1874. From the statistical information in possession of the Association, the production for 1874 was 2,698,413 net tons, against 2,868,278 net tons in 1873, and 2,854,558 net tons in 1872; showing a decrease of 178,865 tons as compared with 1873, and of 165,145 tons as compared with 1872. Notwithstanding this decrease, however, the production for 1874 is much larger than had been generally anticipated by those best informed.

The accompanying statistical résumé will give a general view of the subject in its bearing upon the past three (3) years:

Years.	No. of Furnaces January 1.	No. of Furnaces built during the year.	Total number of Furnaces December 31.	Out of blast December 31.	In blast December 31.	Production of Pig-iron in net tons.
1872....	*574	41	615	‡115	500	2,854,558
1873....	615	50	665	252	413	2,868,278
1874....	†665	38	701	336	365	2,698,413

The comparatively (and unexpectedly) large production of pig-iron in 1874 the Secretary inclines to attribute partly to the strong hope that was entertained by many manufacturers at the outset of the last year that the depressing effects of the financial panic would soon disappear; and partly to the fact that, of the 413 furnaces that continued to make iron, nearly every one of the large, new, and improved furnaces erected in 1872 and 1873 was included, while those out of blast were furnaces of comparatively small capacity. It was not until near the end of the year that a general determination to blow out was reached, and pending the agitation of this question the few furnaces that were blown out were offset by others (some of them new) that were blown in.

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* Including three spiegeleisen furnaces in New Jersey.

† Two furnaces were abandoned in 1874.

‡ Estimated.

On the 1st of February, 1875, of 701 completed furnaces in the country there were in blast 303 stacks, and out of blast 398. Sixty-two furnaces were blown out in January. Since February 1st the number of furnaces out of blast has been slightly increased. The number of new furnaces completed in 1874 was 38, against 50 in 1873, and 41 in 1872. The Secretary has information that since January 1, 1875, no less than 46 new stacks were in course of construction, while others are projected. The bituminous coal and coke district of Ohio showed the greatest increase of production during 1874, while the Lehigh anthracite district of Pennsylvania is credited with the greatest decrease.

IRON PRODUCTION IN FRANCE.

In 1874 France produced 1,360,000 tons of pig (crude) iron, 760,000 tons of wrought iron, and 155,500 tons of steel. —3 *A*, *March* 13, 1875, 334.

UTILIZING FURNACE SLAG.

Mr. W. Harold Smith proposes to utilize furnace slag by manufacturing therefrom a cheap and serviceable substitute for bricks and stone for paving and building. In the process invented by him the slag is granulated as it comes from the stack, then mixed with two thirds its weight of cement and subjected to heavy pressure. In this manner he has succeeded in producing smooth, firm, solid blocks that have withstood the severest application of heat and cold.—*Bulletin*, IX., 189.

MANGANIFEROUS IRON.

Iron rich in manganese, or spiegeleisen, has, according to Troost and Hautefeuille, some striking points of difference from common cast iron. For instance, as the latter flows from the furnace it scatters many brilliant sparks, and in cooling disengages, intermittently, bubbles of gas. Spiegeleisen, on the other hand, from the moment it issues out of the furnace until it is cooled, emits such large quantities of combustible gas as to be covered with a continuous layer of flame. Even after cooling this difference is to be traced in the fact that the manganiferous iron retains a much larger proportion of gaseous constituents than the other, hydrogen of course predominating. Thus a quantity of cast iron yielded 16.7 parts of mixed gases, while the same weight of spiegeleisen gave up 29.5 parts. Carbonized manganese was found by direct experiment to absorb a much greater amount of hydrogen than iron containing the same proportion of carbon.—6 *B, April* 5, 909.

STEEL DIRECT FROM THE ORE.

The system *Ponsard*, for producing steel direct from iron ore, has attracted much attention. *La Metallurgie* gives the following account of an experiment made on this system: For several years metallurgists have essayed to treat iron ores in a reverberatory furnace instead of the blast-furnace, which, besides being very costly, can only, as yet, be worked with coke or charcoal, of which the cost has largely increased of late years. All the attempts made in Europe and America have heretofore been unsatisfactory; but the problem has at last been solved. On the 27th of September, at the forge of the Verrières, at Vienne, France, the first production of pig-iron by the direct treatment of the ore in the gas reverberatory furnace, system *Ponsard*, took place under the superintendence of the inventor, with the assistance of M. S. Perissé, director of the General Metallurgical Society of Paris. The apparatus consists principally of a gazogene which transforms the fuel in a series of large chambers, and of a brick appendage, called the recuperator of heat, which receives the flames from the furnace, and restores the caloric in the form of hot air. The compartments of the chamber serve successively for the reduction of the ore, for the reactions which are effected, and, finally, for the fusion of the whole charge in such a manner that the separation of the component parts is effected by the difference of density. These various phases of the operation require very different temperatures, and the production of these is the special object of the apparatus. On the side of the furnace doors the temperature is only that of red heat, while beyond the heat is so great that the eye is unable to support the intensity of the glow. This extraordinary heat is estimated at 2000° Centigrade.

The success of the experiment is reported to have surpassed all expectations, and the result obtained is considered to demonstrate the possibility of producing steel direct from the ore, without any of the transformations necessary under existing systems. Of course, this is a novelty in the history of metallurgical industry; and it is almost unnecessary to add that, should the system in daily practice justify the report, it will prove a revolution indeed.—3 *A*, *Oct.* 24, 1874.

REVOLVING FURNACE FOR PUDDLING IRON.

A revolving furnace for puddling iron, the invention of Mr. Crampton, has lately been presented to the notice of the Iron and Steel Institute of Great Britain. Small coal or slack is utilized as fuel, and is introduced with a current of air in such a way as to insure perfect combustion, and the consequent absence of smoke. An intense though regular temperature is obtained. A great economy of fuel is claimed for this apparatus, as well as great rapidity of action; since, with a furnace twelve feet in length and six in diameter, the inventor has puddled pig-iron in an hour and a quarter from the time it was cold.—16 *A*, *Oct.*, 1874, 539.

MAGNETIC ORE SEPARATOR.

A magnetic ore separator has lately been invented by Mr. King, in England, for the purpose of separating iron ore from other minerals when associated with them. It is at present employed at the Ballycorkish Mines, on the Isle of Man, where the ore consists of a mixture of galena, blende, and spathose iron ore. The galena can easily be set free, in consequence of its greater specific gravity; but the blende and the spathic ore can not be separated by any ordinary means. A perfectly satisfactory result is obtained, however, by means of the magnetic ore separator. The ore, after being crushed, is roasted at a dull red heat in revolving retorts, when the carbonate of iron is decomposed, and a magnetic oxide produced. The ore is then transferred to the hopper of the magnetic apparatus, which consists of a large drum wheel about eighteen inches in diameter and ten in breadth, furnished within with a system of magnets, arranged radially. The mixed ore, in its passage over a series of four of these drums, has its magnetic portion gradually separated by attraction, and the part that escapes is clean blende.—16 *A*, *Oct.*, 1874, 539.

DISCOVERING THE CHARACTER AND COMPOSITION OF IRON AND STEEL BY ETCHING.

Of late years it has been ascertained that much information can be gathered as to the chemical composition and physical character of iron and steel by etching it, and watching the changes which take place during the operation, and the appearance of the surface after it is completed. According to Professor Kick, of Prague, the best etching substance consists of a mixture of equal parts of hydrochloric acid and water, to which is to be added a trace of chloride of antimony (one drop to the quart of acid). The latter substance seems to render the iron less inclined to rust, so that, after washing thoroughly in warm water and applying a coat of varnish, the etched surface may be preserved quite clean. The smooth surface to be etched is first surrounded with a ridge of wax an inch high, and the water poured into the disk thus formed at a temperature of 55° to 65° Fahr. The action soon begins. The time required for completion is from one to two hours, but the operation should continue until the texture is visible. Every half hour the acid can be poured off without removing the wax, the carbon rinsed off, and the surface examined. When the etching is finished, the wax is removed, the iron washed first with water containing a little alkali, then clean water, brushed, dried, and varnished.—3 *A*, *Oct.* 24, 1874, 523.

NOVEL PHENOMENON DURING THE FORGING OF METALLIC BARS.

At the forging of the bar of iridium-platinum-alloy for the standard meter, M. Tresca states that there were sometimes produced, upon the lateral faces of the piece under the action of the hammer, streaks of light having an oblique direction. When a bar of metal is lengthened by the blow of a hammer on an anvil of the same form as the head of the hammer, which blow produces above and below a symmetrical contraction, the effect of the blows is to give to the bar the aspect of a series of projections, separated by small level spaces. At the time of the collision these spaces are connected, at a certain moment, upon the said face of the bar, by luminous lines passing from one to the other, and presenting altogether an appearance of an X written in lines of fire. The phenomenon is only visible at a certain temperature of the bar; and the bands appear simultaneously, but do not disappear together, so that several of these luminous cross-bars are visible at one time. M. Tresca explains this phenomenon as due to the fact that the band which becomes luminous is that along which the plastic metal mainly flows at the moment when the change of form takes place under the hammer. The bright streak, therefore, gives an exact knowledge of the mode of distortion that obtains during the forging. The phenomenon ought to be the same for all metals, except that the relative hardness, capacity for heat, etc., of the metals will determine the brightness, and thence the visibility of the lines.—12 *A*, X., 401.

TUNGSTEN-STEEL.

A simple and, it is claimed, certain process has been perfected by Biermann, of Hanover, by which a white, exceedingly hard and brittle cast iron, containing from five to forty per cent. of tungsten, can be produced, which is adapted to chilled work, and can be added to cast iron in any proportions.—15 *C*, XVII., 1874, 272.

INCREASING THE HARDNESS AND DURABILITY OF SANDSTONE BY IMPREGNATING IT WITH SILICATE OF ALUMINA.

Lewin has obtained most excellent results by impregnating the beautiful, pure, and porous sandstone of the quarries of Neuendorf, at Pirna, with silicate of alumina, employing a solution of sulphate of alumina, and one of silicate of potash. The stone thus treated is preferable to marble for many purposes, and is said to surpass decidedly the artificial stone already much used, especially in hardness and appearance. By polishing, it can also be made to resemble marble, and by subjecting it to a high temperature it receives a kind of glaze, to which any color may be imparted. In the impregnation it can also be colored, according to the use to be made of it. It is said to resist fire and the atmosphere, and also to be well adapted to water-walls.—8 *C*, *Dec.* 17, 1874, 449.

PRESERVATION OF CLAY PAVING-BRICKS.

According to experiments made in Stuttgart, it was found that bricks that had been coated three times with linseed-oil were less smeary, from wear, in wet weather, as well as more free from dust in summer, than those that had not been so treated. The cheaper petroleum residues were also employed instead of the linseed-oil. Saturation of paving-bricks, sandstone, etc., about manufactories, with hot tar, is also highly recommended where the black color is not objectionable.—5 *C*, XXXII., 255.

INCREASING THE ADHESIVE POWER OF CEMENT.

According to Walters, the force of cohesion in cement may be increased in three ways: by pressure from without; by increase in the volume of single constituents; and by displacement of single constituents, produced by their solubility, taken in connection with attraction and crystallization.

The first of these actions may be greatly facilitated by the workman with his trowel; the absorption of water and carbonic acid from the air produces an increase of volume; and the solubility of some constituents effects their transportation to places where the pressure is comparatively small, and where, on subsequent solidification, they serve to bind the whole more firmly together. The second of these processes is the most important, but unless the proportion between the space left for expansion and the expansion itself be regarded, the mortar will not hold.

According to the author, the chief desideratum of a good mortar is that it shall become impervious to moisture on the outside. This is best fulfilled by Portland cement, which, in increasing in volume, becomes almost entirely indifferent to the action of carbonic acid and moisture.—21 *A*, *July*, 1874, 671.

PRESERVATION OF TIMBER.

Several notices have recently appeared in regard to the merits of the patent process of Rev. Dr. Jones, of Tavistock, England, for rendering timber uninflammable, and preventing dry rot and decay, and for rendering the softer kinds of timber as hard and durable as oak or teak. The process consists in impregnating the timber with a hot solution of tungstate of soda, the expense being estimated at about six cents per cubic foot, and probably less when a large quantity is treated at one time. It is stated that the trials that have been made are perfectly satisfactory, and that the British government has entered into an agreement with the patentee for the use of the method in the government yards.—2 *A*, *June* 26, 805.

PRESERVATION OF TIMBER BY LIME.

The use of lime for the preservation of wood, especially for railroad purposes, has lately been urged by Lostal, who simply piles the planks in a tank, and places over all a layer of quicklime, which is gradually slaked with water. Timber for mines requires about a week to become thoroughly impregnated, and wood for other purposes more or less time, according to thickness. It is claimed that wood prepared in this way acquires a remarkable consistency and hardness, and will never rot. Beech wood has been prepared in this way for hammers and other tools for iron-works; and it is said to become as hard as oak without losing its elasticity or toughness, and to last much longer than when unprepared. —3 *A*, *April* 24, 523.

PRESERVATION OF WOOD BY MEANS OF IRON.

According to Hubert, iron has always been recognized as the best preservative for wood, and the difficulty in its application does not lie in the impregnation of the wood with it, but in the retention of it in the wood in its most effective form as hydrated sesquioxide, which not only displaces the albumen and other nitrogenous matter, but also renders the wood unfit for the support of insects. Copper, although of great value in this respect, may be dispensed with, and it is not applicable in earth containing ammoniacal matter. It is sufficient, in order to impregnate wood with iron, to drive into it long thin nails with broad, flat heads. These, upon rusting, when the wood is placed in the ground, continually distribute iron through the whole mass of the wood. If preferable, the wood may be wound with iron wire. Wood has been preserved in this way, in moist earth, for fifteen years; and it is a fact, often noticed, that in old buildings the wood filled with nails has remained sound, while the rest has completely gone to decay.—14 *C*, CCXIII., 1874, 529.

USE OF CARBONIC ACID GAS IN DRYING AND SEASONING TIMBER.

According to a recent patent, moist carbonic acid gas may be used advantageously in drying and seasoning timber. For this purpose the timber to be dried is placed in a properly constructed chamber, and a fire lighted underneath, or hot gases conveyed through the chamber, so as to produce the necessary temperature. With the timber in the chamber is placed a certain amount of water, and the products of combustion, containing of course a large amount of carbonic acid gas, are introduced into the same space. The carbonic acid gas is rendered moist by means of the water, and being heated to a considerable degree, acts directly upon the sap of the green wood, and, in dissolving it, causes it to give out some of its hydrogen, which, combining with the oxygen of the acid, forms water, and then is evaporated, leaving some of the carbon of the carbonic acid in the wood. The removal of some of the hydrogen renders the wood less productive of flame, while the action of the carbonic acid tends to prevent decay in the wood, or to arrest it in the early stage. For this operation the greener the wood the better. It is maintained by the inventor that, if the process is properly conducted, and the wood not too rapidly heated, no piece of wood needs to be split or damaged in drying; that cracks which may have already appeared will not be increased; and that in every respect the quality of the wood is greatly improved, becoming much harder and denser. The cost of fuel in England, for a load of fifty-two cubic feet of scantling, is estimated not to exceed two shillings, and planks three inches thick, of almost any hard wood, dry in six to eight weeks.—18 *A*, *January* 8, 1875, 416.

THE STRENGTH OF WOOD AND THE EFFICIENCY OF THE AXE.

In a recent volume of the annals of the Forest Academy, at Mariabrünn, near Vienna, Professor W. F. Exner gives a novel and highly instructive analysis of the elasticity and strength of wood, its resistance to splitting, and the theory of the use of the wedge, the axe, etc. The importance of these matters he shows to be very great, because great industries depend upon the facility with which wood can be split, and upon the applicability of certain kinds of wood. Having deduced a few simple formulæ to express the strengths of woods and the power of the wedge, he develops a formula for the force with which an axe is handled, and shows what curve should be given to the face or cheek of the axe in order to secure, under certain conditions, the least waste of power. By means of these formulæ he is able to demonstrate that the splitting efficiencies of the best axes made in Vienna, Prague, and America are to each other as 13.3, 9.2, and 4.9 respectively; and, applying his formulæ to the elaborate experiments of Nördlingen, he is able to deduce the absolute ease with which various woods can be split.—*Annals Mariabrünn Forest*, I., 184.

THE CONSTRUCTION OF WINDING STAIRCASES.

In Major Elliott's Report on European Light-houses he notes that in several cases the stairs are circular, and apparently self-supporting, one end only being built into the wall, as in the Treasury at Washington. This method of stair-building is, he observes, universal in Europe, both in private and public buildings. The most recent light-house towers of the American system are constructed with conical interior walls, and iron staircases winding around the interior of the cone. European towers are generally constructed with an exterior conical and an interior cylindrical wall, leaving an unnecessarily large unused space between the two. The amount of masonry in the American system is the same as in the European, and is better calculated to resist the overturning effect of the severest gales.—*Elliott's European Light-house System*, p. 106.

WALKER'S PATENT ROLLING CARS.

Among other interesting engineering and mechanical novelties, we find reference in *The London Iron* to what is called Walker's Patent Rolling Cars, in which the wheels of an ordinary railroad track are replaced by cylinders, with wheelheads, and which when combined in pairs, as ordinary car-wheels, are drawn over the track. As this constitutes practically one rolling body, a comparatively small engine is sufficient to convey the train. The invention has been made, with special reference to the interest of India, for carrying goods, coal, and even water over long distances, through a thinly populated country at the least possible expense. They are protected from the danger of fire and water, and involve a minimum of dead weight.—3 *A*, *September* 26, 1874, 393.

IMPROVEMENTS IN MINERS' SAFETY-LAMPS.

In speaking of sounding and sensitive flames, Mr. A. S. Herschel states that in the application of them to the construction of miners' safety-lamps, which shall make an audible noise on the approach of dangerous gases, we must avoid any vibrations except the extremely small oscillations of a high-pitched note, otherwise elements of danger may be apprehended from the sounding action of the flame. According to Dr. Irvine, the state of musical sensitiveness in Barry's wire gauze sensitive flame is due to the increased inflammability of the burning gas mixture. The gas current, before reaching the wire gauze, will naturally entangle and mix with it a larger quantity of air when it is disturbed than when it issues smoothly. Such a disturbance is produced by the action of external sounds, under whose influence the appearance of the flame is more contracted and boisterous than when the gas jet burns in a surrounding atmosphere of quiescent air.—12 *A*, XI., 1874, 88.

IMPROVED CLOCK-WORK GOVERNOR.

In order to secure perfectly regular motion in the clockwork applied to revolving lights in light-houses, Dr. Hopkinson, the scientific adviser of the glass-works of Messrs. Chance & Co., near Birmingham, states that he has introduced a simple centrifugal governor. The governor balls have to lift a heavy weight, which is in the form of a fly-wheel, the circumference of which, on being raised slightly, presses against certain fixed pads, the friction of which soon diminishes the velocity of rotation of the fly-wheel and the governors, sufficiently to allow these latter to fall back to their original position. He calculates that work to the extent of five hundred pounds per minute must be done on the governor in order to accelerate the clock one second per hour. This form of governor possesses the advantage that it checks any acceleration of the clock more promptly than when friction rubbers are carried by the governor balls; and it is also easy to adjust.—12 *A*, X., 460.

INHALATION OF OXYGEN MIXED WITH AIR, BY DIVERS, ETC.

It is stated by Gaudin that, in repeating the experiments of Touzet, by the inhalation of a mixture of equal parts of air and oxygen, he experienced an unusually comfortable sensation, which so far removed the disposition to continue respiration that he could hold his nose and close his mouth without any discomfort for five minutes—a fact which, he suggests, may be of service to divers.—14 *C*, CCXIII., 1874, 531.

NEW SPEAKING AND HEARING TRUMPET FOR DIVERS.

An apparatus, patented by Bremen & Co., of Kiel, and introduced for trial into the German Imperial navy, not only enables the diver to communicate with those at the air-pump, but also to hear distinctly, to a depth of sixteen fathoms, every word spoken at the surface. The absolute safety of the diver being thus secured, it is expected they will be able to work for smaller wages, thus rendering their services available in many cases in which they would otherwise be too costly. It is said that the invention is very *simple*, and can be attached, without much expense, to any diving apparatus. The main principle involved is the application of vibrating metallic plates for the propagation of the sound, without, however, allowing them to come in contact with the water.—8 *C*, *Nov.* 19, 1874, 415.

APPARATUS FOR RECORDING SIGNALS AUTOMATICALLY.

Mr. W. Smith gave an account before the British Association of an apparatus devised by him for recording signals automatically, on a paper, in connection with the movement of railway trains, so as to show exactly the circumstances under which the movements of the train had been directed and executed. The apparatus itself records: 1. The direction given and received for regulating the movements of trains. 2. The movement of every signal of every kind or description. 3. The movements of the points and other portions of the road and way affecting the movements of trains or engines. 4. The passing of trains in every direction; and, 5. The time and relation to such movements, etc., all in a succinct form, upon the same roll or strip of paper. These results are obtained by connecting with the reciprocating parts of the points and signal-working, or with the interlocking gear, a peculiar arrangement of electric contact making and breaking apparatus, acting through a simple electro-magnetic contrivance, which, in turn, operates on and deflects a pen or style, which records upon the strip of paper the movements in question.—15 *A*, *Sept.* 5, 1874, 323.

HISTORY OF DUPLEX TELEGRAPHY.

In an investigation into the mathematical theory of the workings of duplex telegraphy, the author, Mr. Schwendler, electrical engineer of the Indian government, gives a short sketch of the history of duplex telegraphy, in which he states that as early as 1849 Messrs. Siemens & Halske, of Berlin, took out a patent in England for the simultaneous transmission of a plurality of messages. In 1854 Dr. Gintl, of Vienna, effected the practical solution of the same problem by employing an electro-chemical method, and in the following summer a differential method was independently arrived at by Siemens & Halske, of Berlin, and by Frischen in 1855. In Sweden Edlund employed a differential method, which he had invented in 1848. The theory of Zantedeschi—namely, that of distinguishing electric currents passing simultaneously from opposite directions through the same conductor, without in any way interfering with each other, and on which that physicist has claimed the honor of having first suggested the idea of duplex telegraphy—is characterized by Schwendler as being in direct opposition to the electrical laws which were already known in 1829. None of the above methods had any extended application; they appear to have been attempted doubtingly, and were generally rejected as impracticable. Only recently, after a torpid existence of almost twenty years, has duplex telegraphy secured the amount of public interest it rightly deserves; and to Mr. Stearns, of New York City, is due the credit of having appreciated its value, and by means of his own inventions proved its thorough practicability. The invention of the duplex method ranks second in importance only to Steinheil's discovery in 1837 of the feasibility of employing the earth to complete the electric circuit, instead of a return wire. Of the causes that have thus delayed the introduction of so important a system, perhaps the most striking was the fact that the invention was twenty years ago in advance of the age; and again that the telegraphic profession, young as it is, is far more conservative than is good for the advance of telegraphy.—7 *A*, XLVIII, 122.

BALLOON VOYAGE FROM BUFFALO TO NEW JERSEY.

A very interesting and in some respects remarkable balloon ascension was made on the night of the 4th and morning of the 5th of July, 1874, by the well-known aeronaut S. A. King, of Boston. The ascent was made at Buffalo about six o'clock Saturday evening. The course of the balloon was at first slightly east of south, and gradually changed more to the eastward, until a landing was effected at Salem, New Jersey, about seven o'clock Sunday morning, the entire distance traveled in thirteen hours being, in a direct line, nearly 350 miles. The latter part of the journey lay in the path of the terrible tornado which swept over Eastern Pennsylvania and New Jersey on the afternoon of the 4th of July, and which caused great destruction of crops, etc. The balloon employed in this trip is, with two exceptions, the largest ever built in this country, having a capacity of 91,000 cubic feet. The greatest height attained above the earth's surface was 9750 feet, at which elevation the temperature was 68°, it being then a quarter before seven in the morning. Coggia's comet was watched with much interest, and was seen with great distinctness through the early half of the night.—*Boston Journal, July* 10, 1874.

DISASTROUS TRIP OF THE BALLOON "ZENITH."

The disastrous termination to a balloon ascent lately undertaken in France, in the interest of science, has attracted much attention in Europe; this occurring in the case of the balloon *Zenith*, on the 15th of April, 1875. On that date M. Gaston Tissandier and M. Crocé-Spinelli took passage in the *Zenith*, which was in charge of M. Sivel, the special object of the ascent being the determination of the quantity of carbonic acid gas contained in the atmosphere at an altitude of 24,000 feet. The experiment of the inhalation of oxygen, after attaining a considerable altitude, was tried, to ascertain its effects; but at a height above 22,000 feet M. Tissandier fainted. He was shortly afterward awakened by M. Crocé-Spinelli, who warned him to throw over some ballast, which was done. He then fell asleep for about an hour, and on awakening found the balloon descending at a terrific rate. No more ballast was to be thrown away, and his two friends were suffocated. Their faces had turned black, and the blood was flowing from their mouths and noses. M. Tissandier's only resource was to cut the grapnel rope a little before the instant when the car should strike the ground, and the balloon was torn open to stop it. It was finally caught on a hedge about 190 miles southwest of Paris.

The temperature of minus 10° Centigrade was observed at the height of 22,960 feet, but it was supposed the altitude to which the balloon had ascended was considerably greater, the indication of the self-registering barometer being 14,000 meters, or eight miles.—12 *A*, *April* 24, 1875, 495.

CASING FOR STEAM-PIPES, ETC.

The following composition for casing steam-pipes, etc., is recommended by a German association of engineers as equal in effect to that of Leroy, while it is cheaper: Mix well 120 parts, by weight, of finely ground limestone, 350 of finely ground stone-coal, 250 of finely ground clay, 300 of flue-dust (from the boiler flues), 600 of water, 10 of sulphuric acid of 50° Baumé, and 15 of hair. The place to be covered, warmed if possible, is coated with this mass in layers, from half an inch to 1½ or 2 inches thick, and when finished may be painted.—14 *C*, CCXIII., 1874, 169.

CONSUMPTION OF WOOD BY RAILWAYS.

The National Car Builder reports that at the close of 1873 there were 71,564.9 miles of main lines, and 13,512 miles of sidings and double tracks, making 85,076.9 miles of railway within the United States. Upon these roads the larger proportion of the locomotives consumed wood for their fuel. The number of ties used varies from 2200 to 2800 per mile. Taking 2500 as the mean, it appears that 212,692,500 pieces of timber, eight feet long and from six to eight inches between the upper and lower surfaces, are required to supply this single item. The durability of ties varies, with climate, kind of timber, soil, and usage, from four to ten years. Assuming six years as the average life of a tie, the amount required for annual supply must be 35,488,750 pieces, or 94,530,000 cubic feet. In considering this item it must be remembered that a large amount of waste occurs from hewing and other causes. It must also be borne in mind that the demand for timber by railroads, besides that used for ties and fuel, is enormous, including fencing, bridges, buildings, and other structures in great variety and number; that the risk from fires is exceptionally great, and that our requirements in this direction are increasing even more rapidly than our supplies are wasting away.

GOLD-MINING IN THE PHILIPPINE ISLANDS.

According to a letter from Minard to Daubrée, the working of the auriferous quartz in the Philippines has been abandoned, the alluvial deposits having proved much richer in grains and scales of gold. It is associated with fragments of dioritic rocks, as itaberite, with magnetite and titanic iron, the gold occurring in tolerably large grains, while quartz is seldom present. Native platinum is also found with it, and, in the samples sent, small zircons with quadrangular pyramids on each end were recognized, as they usually occur in auriferous alluvium.—3 *C*, *July* 27, 1874, 600.

NEW CARBONIC ENGINE.

De Beins, of Amsterdam, has communicated the results of his latest experiments with carbonic acid motive-engines. He has for many years studied the question of the transformation of heat into mechanical power, and in seeking to ascertain the degree of pressure evolved by carbonic acid disengaged from bicarbonate of soda heated in a confined space he found that when the bicarbonate of soda, or of potash, either in the condition of dry powder or of an aqueous solution, was heated in a confined space, a part of the carbonic acid became disengaged, and condensed in a cool part of that space, in such a manner that at the temperature of 250°

to 400° C. liquid carbonic acid could be distilled from these salts under a pressure of 50 to 60 atmospheres.

This fact he considers of great importance, as carbonic acid under high pressure (or, as Beins calls it, "Carboleum") is physically a very remarkable body, which may be easily obtained in large quantities. The study of the relations of bodies submitted to high pressure is only in its infancy, and to pursue it a simple apparatus for compression is all-important. For pressures of less than 50 or 60 atmospheres it is of course not necessary to raise the temperature to 300° and 400° C. With a saturated solution of bicarbonate of soda, heated to boiling point in a bath of concentrated common salt, carbonic acid of three to five atmospheres is obtained, and the pressure increases regularly with the temperature.

Carbonic acid at a high pressure, or carboleum, supplies excellent motive power for small and great industries. This was remarked by Faraday, who discovered liquid carbonic acid, and, since, by Thilorier and others; but unfortunately the law of the preservation of the energy, indispensable in such cases, was not known. A liter of carboleum at 15° C., and with a pressure of 50 atmospheres, weighs approximately 0.8 kilos., and will produce 400 liters of carbonic acid at the ordinary pressure. The power required to produce compression to the extent of 50 atmospheres is equal to about 17,000 kilogrammeters. This gives 270,000 kilogrammeters per hour, and per horse-power, for 16 liters of carboleum at 50 atmospheres, and 15° C.

It is only when a carboleum engine works with large intervals between that the heat of evaporation can be carried to the sides without heating artificially. In the majority of cases the carboleum must be evaporated by the artificial heating of small quantities at a time. The heat required per horse-power per hour, as already given, namely, 270,000 kilogrammeters, is equal at least to 640 calorics (0.1 kil. of coal).

Large carboleum engines should be worked with regeneration. They should have a dépôt of salt of soda and carboleum, so arranged that the decomposed bicarbonate shall be regenerated by the carbonic acid which has worked the engine. Such a machine transforms very advantageously into mechanical power the heat supplied by the fire to decompose the bicarbonate constantly regenerated. Supposing the gas to act at the temperature of 100° C., the 16 liters of carboleum necessary per horse-power per hour will be reduced to 10 liters. Such an engine requires about 0.3 kilos. of coal per horse-power per hour, while the best constructed steam-engine consumes 1.2 to 0.9 kilos. For ships, the weight of an engine of 100 horse-power, with fuel for 240 hours, will be one fifth less than that of a steam-engine of equal power. And as several parts of a carboleum engine require to be more massive, it will take up less room. Carboleum presents no danger, as it contains no cause of explosion. It is easy to prevent a too abundant accumulation of gas in the engine-room, which would render the air unfit for respiration. When not in contact with water the metallic parts of the engine are not affected by the carbonic acid. Metals are not permeable by gases at that pressure. In large works the carboleum engine will, it is claimed, in nearly all cases, replace the steam-engine. In small establishments, and especially where the engines are only worked at intervals and for short periods, the fact of the carboleum being always ready to act at a moment's notice is of great importance; as, for instance, to drive printing-presses, steam pumps, portable engines, etc. A carboleum engine is an excellent and economic source of electric light. M. Beins also recommends the carboleum engines as especially adapted to submarine vessels.—3 *A*, *October* 24, 1874.

REPORT ON THE RECLAMATION OF THE ALLUVIAL BASIN OF THE MISSISSIPPI RIVER.

The report of the commission of engineers appointed to investigate and report a permanent plan for the reclamation of the alluvial basin of the Mississippi River subject to inundation has lately been published. This commission, of which General G. K. Warren, of the United States Engineers, was chairman, was appointed under an act of Congress in June, 1874, and held its meetings first at Newport and then at Washington, its members visiting from time to time the localities in the Mississippi Basin requiring particular investigation.

At an early stage in the deliberations it was decided that, although the judicious use of artificial reservoirs in moderating the destructive effects of rivers had its advantages, yet —first, this method of protection against overflow was inapplicable to the lowlands of the Mississippi; second, that no reduction in the height of the floods of the Mississippi can be obtained by diverting any of its tributaries from their present channels; third, that the local benefit above their sites which results from cut-offs is more than counterbalanced by the injury sure to result below in an increased flood-level and caving of the banks; fourth, that outlets of limited capacity, merely sufficient to reduce the flood-level a few feet, would be advantageous, provided a free channel to the Gulf could be found for water so abstracted from the river; fifth, that the expedient of withdrawing water from one part of the river to be subsequently returned below is sufficiently dangerous to be adopted unwillingly, and only as a choice of evils; sixth, that as all cultivation of the Mississippi bottom-lands owes its success to the construction of levees, the committee has confidence that the system properly applied is adequate to the protection of the country against floods. Whether it should be exclusively trusted, or be combined with outlets, is a matter to be decided by economical considerations.

The committee also decided that all openings for overflows previously existing should be maintained, and that one of these outlets (the Bayou Plaquemine) having been closed, it should be reopened, provided it can be done without danger of a disastrous enlargement.

A general levee system extending from the head of the alluvial basin to the Gulf, which shall likewise include valleys of the tributary streams, should also be established. They estimate the total area of the bottom-lands to be about 32,000 square miles, of which but a trifling strip has heretofore been available for agricultural purposes. Should the recommendations of the commission be carried into practice, it is estimated that it would reclaim and make available not less than 2,500,000 acres of sugar land, 7,000,000 acres of unsurpassable cotton land, and 1,000,000 acres of corn land of the best quality. The estimates of cost, etc., which are given as simply approximations, speak of 115,000,000 cubic yards of levee at forty cents per yard, reaching a total of $46,000,000.

JESTY'S ANTI-FOULING COMPOSITION.

The copper sheathing of two royal English yachts was covered in the fall of the year, by order of the Admiralty, with Jesty's Anti-Fouling Composition, and, after remaining moored in the harbor until the end of the following April, they were found as free from algæ and other deposits as when first coated, except in very small patches near the rudder.—14 *C*, CCXIII., 1874, 257.

HYDRAULICS IN THE ADIRONDACK PLATEAU.

At a recent session of the New York Legislature a survey of the Adirondack plateau was authorized, to determine the probable cost of accumulating a reserve of the surplus waters of that region for the use of the Hudson and other streams. This was placed in charge of Professor T. N. Benedict, of New Jersey (formerly of Burlington, Vt.), who has spent much time in the study of the physical and topographical character of the region. The instrumental work was performed by two parties, one under Professor Benedict, and the other under Mr. W. B. Cooper. Professor Benedict took charge of the lakes and ponds of the upper sources of the Hudson, including a part of the Racquette River, while to Mr. Cooper's party was assigned the triangulation of Long and Forked Lakes, and the examination of the Racquette Valley below Long Lake. The gauging of the main channel of the Hudson, above the junction of the Mohawk, was accomplished in October by Professor Benedict.

As the result of these inquiries Professor Benedict reports: first, that immense quantities of water can be safely stored at a comparatively low percentage of cost on the upper Hudson, most of which is now worse than lost, as it runs to waste in spring freshets, which in various ways are the cause of much damage; second, that this excess is sufficient to maintain the deficiency of the main river, at low summer stages, for 100 days, after liberal discount for losses on its passage. The lakes of the Racquette basin, alone, are alleged to have a capacity more than six times that of the Black River reservoirs, which supply the eastern division of the Erie Canal.

HEAT AND PRODUCTS OF GUNPOWDER EXPLOSIONS.

According to recent experiments by Captain Noble and Mr. Abel, the temperature of the explosion of gunpowder, by means of platinum wire or tin-foil, is about 2200° C. The products of explosion consist of about fifty-seven parts, by weight, of solids, to forty-three of permanent gas. When the powder fills the space in which it is fired, the pressure is about 6400 atmospheres, or 42 tons to the square inch. The products of explosion generally are the same in a gun and in a completely closed vessel, while the work on the projectile is due to the elastic pressure of the permanent gases.—3 *A, Nov.* 21, 1874, 66.

EXPLOSIVE AGENTS.

The report of Professor Abel on explosive agents as applied to industrial purposes, delivered to the Institution of Civil Engineers, and the discussions thereon during the past three years, have been recently published in a pamphlet, from which the following facts are taken.

Passing from the consideration of gunpowder to those substances that have been proposed as substitutes therefor, Professor Abel considers the three principal ones as picric acid, nitro-glycerine, and gun-cotton.

Nitro-glycerine has been raised from the position which it held for sixteen years, as a rare and apparently useless chemical, to that of a most important industrial agent, through the skill and perseverance of Mr. Noble, who, in 1863, made public his proposition to add to the explosive power of gunpowder by impregnating the grains with nitro-glycerine. In 1864 Mr. Noble described several methods of exploding charges of nitro-glycerine, and showed that the explosion takes place with such great rapidity that it is unnecessary to confine the charge by tamping or any other means. Nitro-glycerine is now extensively employed, not only in California, but in Sweden, Germany, and Wales. The poisonous nature of the exploding gases, which injuriously affects the health of those handling it, is one of its defects. The material is much less susceptible to accidental detonation in the frozen than in the liquid condition. The accidents which have occurred with frozen nitro-glycerine appear to have arisen from a reckless use of the material. The endeavors of Mr. Noble to diminish the chances of the accidental explosion of the liquid substance led to the production by him, in 1867, of the solid preparation of nitro-glycerine, known under the name of dynamite, which constitutes, as now manufactured, one of the safest, most powerful, and most convenient explosive agents. Dynamite, as originally prepared, consisted of about 75 per cent. of nitro-glycerine absorbed by about 25 per cent. of a porous, infusorial, silicious earth found in Germany. This substance is now furnished to the trade in cartridges whose charges have the consistency of dry putty. During the late siege of Paris attempts were made in that city to substitute some other earth for that used in Germany. The most efficient absorbents were found to be silica, tripoli, alumina, and sugar. None of these, however, is considered to be so efficient as the German mineral. The preparation called glypto-fractur is stated to be a secret composition, but it has been publicly acknowledged by the manufacturers that the material is a modified dynamite, for which, however, special merits in regard to safety and power are claimed. It is difficult, however, to conceive that it can be more powerful than the original pure dynamite, from which it differs principally in containing a larger percentage of earths. Professor Abel believes that Noble's dynamite has a decided superiority over glypto-fractur in respect to the retention of nitro-glycerine at different temperatures. Exploding nitro-glycerine in its pure or liquid form is pre-eminently dangerous, and therefore only likely to receive exceptional application.

Professor Abel makes a comparison between the destructive effects of dynamite and compressed gun-cotton, and states that, generally, in all operations where rapid destruction is to be accomplished, gunpowder is undoubtedly inferior to these new explosive agents. Not only would a much larger quantity of powder be required to produce similar results, but in some cases it would be impossible to perform the same operations. In tunneling in the slate quarries of North Wales, a work that costs 60 shillings per cubic yard for gunpowder is done in less time for 45 shillings per yard with compressed gun-cotton. In experiments made by Mr. Hawkshaw, it was found that a detonation of gun-cotton charges, placed simply upon the surface of submerged soft chalk rock, would break up the latter so as to facilitate its rapid removal by dredging, the rock being completely disintegrated, or pounded into a plastic mass like clay. Comparing the effects of dynamite containing 75 per cent. of nitro-glycerine with those of gun-cotton, the two materials appear to be practically on an equality, weight for weight, but the results furnished by either of them are accepted as being about six times those produced by gunpowder. The most prominent advantage of dynamite over gun-cotton is that it may be used in a damp hole without fear of its missing fire; while, on the other hand, compressed gun-cotton possesses the advantage that it is not in any way injurious to handle, is not at all affected in its explosiveness by cold, and may be preserved for any length of time without deterioration in its damp and unignitable state. The vapors evolved from the explosion of either of these are decidedly more objectionable than gunpowder smoke.—*Abel on Explosive Agents.*

AN INGENIOUS AND NEW MOTOR.

According to the laws of the mechanical theory of heat, mechanical work can be produced by the employment of any differences whatever of heat; and a very simple device has been invented by Bernardi, which is curious, if not of industrial value. Two glass globes are united by thin metallic arms to a central drum, the arms being bent at right angles when they enter the globes. The globes are partly filled with ether. An axle passes through the central drum in such a way that as it revolves, carrying the arm and the globes with it, the globes successively dip into a basin of cold water. Each globe is covered by a very fine network, which, becoming wet in that part of its revolution that carries it below, is subsequently, during the greater part of its revolution, exposed to the air. Evaporation of the water over the exterior of the network, and the consequent cooling of the globe, causes a slight condensation of ether in its interior, more of which is supplied from the opposite globe then being immersed in water, the upper or exposed globe becomes the heavier, and by its tendency to sink keeps the axle in continued but slow rotation, which does not cease so long as water is supplied to wet the globes. A number of such pairs of globes being fastened to the axle, sufficient force is produced to turn a delicate clock-work. An apparatus constructed by Bernardi, with globes having a diameter of three fourths of an inch, and with arms three inches long, has worked for three months without change; in which period he calculates that the quantity of heat consumed by the apparatus has been equivalent to sixty revolutions of the wheel per day.—13 *B*, III., 80.

THE PYROLETER.

A new apparatus for the preservation of life and property from fire at sea, called the Pyroleter, or fire destroyer, was lately tested in England. A barge of some 40 to 50 tons' burden was fitted up for the purpose of the experiment. Along the entire length and width of the hold cotton-waste, shavings, and small wood saturated with oil and naphtha was placed to about the depth of two feet, and ignited on a given signal, within two minutes of which time dense volumes of flame and smoke issued from the open hatchways. The hatchways were then battened down, and the apparatus being set to work, the flames were completely extinguished within four minutes. The Pyroleter, by means of which this result was effected, is a small pump, which draws from tubs placed on each side of it simultaneous supplies of diluted hydrochloric acid and a solution of sodium bicarbonate. Both mixtures then meet in a generator and instantaneously pass into a separator, whence dry carbonic acid gas is evolved, and passes through fixed pipes to the *locale* of the fire, which it speedily suppresses. The chief merit of the invention is that a fire can be readily extinguished by dry gas with the assurance of no damage to the cargo therefrom.

ETCHING IRON.

Much time and attention has been devoted by Professor Kick, of Prague, to the subject of etching iron with acids. His method for arriving at a knowledge of the quality of iron or steel is not a new one, having been used with some success for a long time, but the care with which the Professor has conducted his experiments makes them exceedingly valuable.

Some kinds of iron exhibit what is known as the passive state, and are unacted upon by acids until this state has been destroyed by heating. The surfaces thus prepared are inclined to rust very soon. After a series of experiments with nitric, sulphuric, and hydrochloric acids, and etching solutions of copper salts, Professor Kick found that a mixture of equal parts of hydrochloric acid and water, to which was added a trace of chloride of antimony was the best etching solution. The chloride of antimony seems to render the iron less inclined to rust, so that after washing thoroughly in warm water, and applying a coat of Damar varnish, the etched surface may be preserved quite clean. The smooth surface that is to be etched is surrounded by a ridge of wax an inch high, as is done in etching copper for plates, and the acid is poured into the disk thus formed. At a temperature of 55° to 65° Fahr. the action soon begins, as shown by the gas evolved; in winter the etching is poor. The time required is from one to two hours, but the etching should go on until the texture is visible. Every half-hour the acid can be poured off without renewing the wax, the carbon rinsed off, and the surface examined. If too much chloride of antimony is added to the acid, a black precipitate will soon form, which can easily be distinguished from the carbon. One drop of chloride of antimony to the quart of acid is sufficient. When the etching is finished the wax rim is removed, the iron washed first in water containing a little alkali, then in clean water, brushed, dried, and varnished. If in a few hours it begins to rust, the varnish should be removed with turpentine, which will also take off the rust, and then varnish again.

The appearance of different kinds of iron, when etched, is essentially as follows: Soft or sinewy wrought iron of excellent quality is attacked so equally by the acid, and so little acid is separated, even after several hours' action, that the surface remains bright and smooth. Fine-grained iron acts the same; the surface is still smoother, but a little darker. Coarse-grained and cold-short iron is attacked much more violently by acid than that just mentioned. In ten minutes, especially with cold-short iron, the surface is black. After thirty minutes a black glass can be washed off, and the surface will remain black in spite of repeated washings, and exhibits numerous little moles. Certain parts of the iron are usually eaten deeper, while others, although black and porous, offer more resistance. By allowing the acid to act for an hour or so, then washing, drying, and polishing with a file, a distinct picture is obtained. Malleable cast iron, we know, rusts more easily than wrought iron, and it is an interesting fact that the action of acids is also violent, the surface being attacked very intensely. Gray pig-iron acts like steel; the etched surfaces have quite a uniform gray color. In puddled steel the color of the etching and washing is gray, with a uniform shade, and the lines are scarcely visible. Cement steel has a very similar appearance, the lines being very weak. In Bessemer and cast steel the surfaces etched are of a perfectly uniform gray color, with few, if any, uneven places. The softer the steel the lighter the color. On etching, the finest hair-like fractures are rendered prominent. A piece of steel, which looked perfect before etching, afterward exhibited a hair-like fracture throughout its whole length. When different kinds of iron are mixed, the acid attacks that for which it has the greater affinity, while the other is less acted upon than if it were alone. Etching is exceedingly valuable to all who deal largely in iron, as it enables them to determine with comparative accuracy the method of preparing the iron, as in the case of rails, etc., as well as the kinds employed. —3 *A*, *October* 4, 1874, 523.

SCHMITZ'S REVOLVING FURNACE-BARS.

The *London Iron* speaks with much approbation of Schmitz's Revolving Furnace-bars, in which the ordinary straight fire bars are replaced, singly or in pairs, by hollow cylindrical bars, pierced with holes, and so arranged as to be easily capable of revolution. These bars rest on supports which are themselves cylindrical and hollow, and are supported lengthwise by a plate beneath the door of the fire-box, and fitting into a neck made at the near end of the bar. For revolving them a winch is inserted in the hexagonal opening in the front end of the bars, by which they are turned.

The lighting of the furnace is performed in the ordinary way, and the furnace door can be kept completely closed, the perforations of the hollow bars supplying as much air as is necessary, and to a much greater advantage, as it passes directly through the coal instead of playing on the top; and the combustion is much more uniform and thorough. At intervals the bar is turned partly round, and a clear surface free from slag and scale is presented to the fuel. The ashes which fall through the perforations of the grate can be pushed out into the ash-pit, thus avoiding the necessity of raking down.

Another advantage claimed for this grate is that a larger charge of coal can be put into the furnace than usual, thus avoiding the necessity of a frequent opening of the front. In an experiment by the Paris Gas Company with these bars, the fuel used was an agglomerated coke dust—which could not be used in ordinary furnaces—and which resulted in complete success, and by which it was claimed that a saving of 26 per cent. was made.—3 *A*, *April* 24, 520.

CORK AS A NON-CONDUCTOR OF HEAT.

Experiments conducted at several important works in France, during a number of months, are declared to have established the fact that cork is entitled to the first rank as a non-conducting substance well adapted for the purposes of practice. In the account from which our information is derived, it is said that after eighteen months of service upon the steam-pipes of sundry establishments, the cork remained intact, and had suffered no practical deterioration of quality. Although the durability of this substance had been proved before by the buoys which are subjected to the severe test of a partial immersion in water and exposure to weather, its ability to withstand such high temperatures as those of steam-heated surfaces required experimental demonstration. This point, according to our authority, has been satisfactorily settled. In addition to its durability, its lightness, the readiness with which it yields so as to surround the cylinders or pipes, the facility with which it can be taken down and put in place again whenever inspection or repairs of boilers and pipes require it, and above all its eminent non-conducting powers, entitle it to the first rank as a heat-saving lining to steam-pipes and for related applications. The engineers of the French Navy, after a lengthy examination of its merits, have, according to accounts, given it their formal approval in a report to the French Admiralty. In view of the deficiencies of most of the materials hitherto employed by steam users for the above purpose, the claims of cork to such eminent practical utility may be worth an examination.—*La Metallurgie.*

THE NEW MONSTER CANNON OF ENGLAND.

When the English had cast their cannon, the "Woolwich Infant," of 35 tons, it was supposed that the limit attainable by engineers had been reached, and would not soon be surpassed. But the success of the first infant seems to have been only an incentive, and now the world is astonished by the appearance of a new monstrous cannon of 81 tons, destined to form a part of the armament of the iron-clad *Inflexible.* It is well understood, even by those not professional engineers, that the perfection of metallurgical processes has enabled the art of defense to keep pace with that of attack. The old cannon of 25 tons, and its projectile of 700 pounds, were no sooner eclipsed by the production of heavier iron-clads, than the cannon of 35 tons was made in order to overcome the new resistance. No sooner was the latter ordnance finished than the Russians constructed an iron defense of 20 inches' thickness, on which the 35-ton cannon had no effect, as shown by the experiments at Shoeburyness and Woolwich. It became then urgent to construct a new type of cannon more powerful than its predecessors, which should be able to cope with the defenses of the Russian monitors. An 81-ton monster is accordingly now nearly finished. It is constructed according to the method of Frazer, which differs from that of Armstrong in that the fibres of the hoops around the breech which inclose the steel tube, instead of being placed lengthwise of the cannon, are disposed transversely to its axis, which gives the metal greater resistance to the shock of explosion. The whole is formed of seven pieces: five hoops of forged iron, one tube of steel, and the solid breech end. Its total length is 27 feet; its calibre, when finished, will be 16 inches, but the first series of trials will be made with a calibre of 15 inches, after which the gun will be still further bored out. Its trial will take place in July at Shoeburyness, the charge being over 300 pounds of powder, and the weight of the projectile over 1700 pounds. Its range under these conditions is estimated to be about six miles, and the force of the projectile is such that it will pierce a plate of iron 25 inches thick at a distance of one mile. The entire equipment of the *Inflexible* comprises four pieces of ordnance of this same size.—13 *B*, III., 100.

CEMENT FOR MARBLE AND ALABASTER.

We find in the *Bulletin* of the Chemical Society of Paris the following formula for a cement for marble and alabaster: 12 parts of Portland cement, 6 parts slaked lime, 6 parts fine sand, and 1 part of infusorial earth are made into a thick paste with silicate of soda or soluble glass. The object to be cemented does not require to be heated. It sets in twenty-four hours, and the fracture can not be readily found.—1 *A*, *April* 23, 185.

PREVENTING INCRUSTATION IN STEAM-BOILERS.

Among the many devices for preventing incrustation in steam-boilers, that of lining them with thin copper plates is said to be very effective. In certain cases, where the boiler had strips of copper placed inside of it, other portions not being covered, after a certain time it was found that the uncoated portions were incrusted five and six times as much as the copper-lined, the copper remaining also uncorroded. It is claimed that in addition to the diminished amount of incrustation and the less corrosion of the copper, the vaporization is more complete, and that there is a corresponding saving of fuel.

In the construction of a boiler to be lined with copper, it is stated, and not without reason, that the weight of the boiler is considerably reduced, since the iron plates may be of less thickness, and the expense thereby diminished. It is remarked, however, that the question still remains as to the galvanic effect of the contact of the two metals, and the action of waters less calcareous but more acid than that with which the experiments referred to were prosecuted.—3 *A*, *June* 5, 715.

COPPER LINING FOR STEAM-BOILERS.

The editor of the *Engineering and Mining Journal*, in referring to the above suggestion of using a lining of copper for the protection of boilers from incrustation, remarks that such a combination has been found very injurious, on account of the galvanic action of the two metals, and that more satisfactory experiments are required, with waters of different qualities, particularly with the acid water common in coal-mines, before much reliance can be placed upon the so-called improvement.—*Engineering and Mining Journal, June* 26, 478.

ELECTRIC FUSES.

A series of memoirs and discussions on the subject of electric fuses and the efficiency of torpedoes, submarine blasting operations, etc., has occupied the attention of the Society of Telegraphic Engineers; and among the papers presented, especial interest attaches to that of Professor Abel, on account of his extensive experience in these matters. He holds the opinion that the many disappointments and accidents that have occurred in connection with electric fuses are, in general, not to be attributed to the electricity nor to the fuses, but rather to the carelessness of the operators. It can always be shown by a preliminary calculation whether a given galvanic battery can possibly heat a fine wire white hot, or whether it will fail to heat it hot enough to explode the fuse. His own experiments confirm the practice of some American constructors of torpedoes, in finding that both German-silver and platinum-silver alloys are greatly superior to platinum in regard to the resistance opposed to the passage of the electric currents, and consequently develop greater amounts of heat for wires of given lengths and diameters. German silver is superior in this respect to platinum silver. The most insidious cause of failure of electric fuses is found in the corrosion due to moisture; and for the construction of low tension fuses the wire must be selected which possesses the power of resisting corrosion when in immediate contact with the material of which the fuse is formed. In this respect German-silver wires, although inclosed in tubes, were found to deteriorate very slightly during the first forty days of their exposure, while platinum-silver wires in close tubes remained constant. When the gunpowder is wet, the German silver has much greater liability to corrosion. The charcoal is apparently that element of the gunpowder which promotes corrosion. In general, the alloy composed of one third platinum and two thirds silver is superior both to the pure platinum and to the German silver; and this alloy has been admitted by the British Association Committee as the material for the reproduction of standards of electrical resistance. An alloy of platinum and iridium containing seven and one-tenth per cent. of the latter metal, proved as efficient in the protection of sensitive fuses as the finest silver platinum, and has moreover the advantage of being much stronger, and more reliable as regards uniformity of composition. It is, however, much less fusible than the platinum silver, so that the latter has the advantage when a large number of branch circuits of different lengths are to be fired simultaneously. The larger the percentage of iridium, the greater the resisting power of the alloy. An equally efficient material is found in an alloy of silver with twenty-five per cent. of palladium. The best method of constructing a fuse, so as to insure a thoroughly efficient priming, consists in preparing a very fine gun-cotton powder, by taking dry pulp gun-cotton, or compressed gun-cotton scraped off or broken up to powder, and sifting this through muslin. The dust thus obtained is intimately mixed, by means of a feather or hair-pencil, with sufficient mealed gunpowder, or detonating powder, to make it flow readily into a small cavity. When the breach of the fuse has been fixed in position, this priming-paper may be poured in, and made to surround it.

ORGANIZATION OF THE UNITED STATES BOARD FOR TESTING IRON AND STEEL.

The appointment of a government commission for the purpose of experimentally determining the strength and value of iron, steel, and similar materials for construction, has been referred to upon another page, in a note stating generally the objects which it was the problem of the commission to realize, and its *personnel.* In pursuance of the conditions of the act of appointment, the commission has met and organized the following standing committees to take charge of special branches of their work, viz.:

ON ABRASION AND WEAR (A): R. H. Thurston, C. E., chairman; A. L. Holley, C. E., Chief Engineer D. Smith, U. S. N.

Instructions.—To examine and report upon the abrasion and wear of railway wheels, axles, rails, and other materials, under conditions of actual use.

On Armor Plate (B): Lieutenant-colonel Q. A. Gillmore, U. S. A., chairman; A. L. Holley, C. E.; R. H. Thurston, C. E. *Instructions.*—To make tests of armor plate, and to collect data derived from experiments already made to determine the characteristics of metal suitable for such use.

On Chemical Research (C): A. L. Holley, C. E., chairman; R. H. Thurston, C. E. *Instructions.*—To plan and conduct investigations of mutual relations of the chemical and mechanical properties of metals.

On Chains and Wire Ropes (D): Commander L. A. Beardslee, U. S. N., chairman; Lieutenant-colonel Q. A. Gillmore, U. S. A.; Chief Engineer D. Smith, U. S. N. *Instructions.*—To determine the character of iron best adapted for chain cables, the best form and proportions of link, and the qualities of metal used in the manufacture of iron and steel wire-rope.

On Corrosion of Metals (E): W. Sooy Smith, C. E., chairman; Lieutenant-colonel Q. A. Gillmore, U. S. A.; Commander L. Beardslee, U. S. N. *Instructions.*—To investigate the subject of the corrosion of metals under the conditions of actual use.

On the Effects of Temperature (F): R. H. Thurston, C. E., chairman; Lieutenant-colonel Q. A. Gillmore, U. S. A.; Commander L. A. Beardslee, U. S. N. *Instructions.*—To investigate the effects of variations of temperature upon the strength and other qualities of iron, steel, and other metals.

On Girders and Columns (G): W. Sooy Smith, C. E., chairman; Lieutenant-colonel Q. A. Gillmore, U. S. A.; Chief Engineer D. Smith, U. S. N. *Instructions.*—To arrange and conduct experiments to determine the laws of resistance of beams, girders, and columns to change of form and fracture.

On Iron, Malleable (H): Commander L. A. Beardslee, U. S. N., chairman; W. Sooy Smith, C. E.; A. L. Holley, C. E. *Instructions.*—To examine and report upon the mechanical and physical properties of wrought iron.

On Iron, Cast (I): Lieutenant-colonel Q. A. Gillmore, U. S. A., chairman; R. H. Thurston, C. E.; Chief Engineer D.

Smith, U. S. N. *Instructions.*—To consider and report upon the mechanical and physical properties of cast iron.

ON METALLIC ALLOYS (J): R. H. Thurston, C. E., chairman; Commander L. A. Beardslee, U. S. N.; Chief Engineer D. Smith, U. S. N. *Instructions.*—To assume charge of a series of experiments on the characteristics of alloys, and an investigation of the laws of combination.

ON ORTHOGONAL SIMULTANEOUS STRAINS (K): W. Sooy Smith, C. E., chairman; Commander L. A. Beardslee, U. S. N.; R. H. Thurston, C. E. *Instructions.*—To plan and conduct a series of experiments on simultaneous orthogonal strains, with a view to the determination of laws.

ON PHYSICAL PHENOMENA (L): W. Sooy Smith, C. E., chairman; A. L. Holley, C. E.; R. H. Thurston, C. E. *Instructions.*—To make a special investigation of the physical phenomena accompanying the distortion and rupture of materials.

ON RE-HEATING AND RE-ROLLING (M): Commander L. A. Beardslee, U. S. N., chairman; Chief Engineer D. Smith, U. S. N.; W. Sooy Smith, C. E. *Instructions.*—To observe and to experiment upon the effects of re-heating and re-rolling, or otherwise re-working, of hammering as compared with rolling, and of annealing the metals.

ON STEELS PRODUCED BY MODERN PROCESSES (N): A. L. Holley, C. E., chairman; Chief Engineer D. Smith, U. S. N.; W. Sooy Smith, C. E. *Instructions.* — To investigate the constitution and characteristics of steels made by the Bessemer and other modern methods.

ON STEEL FOR TOOLS (O): Chief Engineer D. Smith, U. S. N., chairman; Commander Beardslee, U. S. N.; W. Sooy Smith, U. S. N. *Instructions.*—To determine the constitution and characteristics and the special adaptation of steels used for tools.

The secretary of the board announces that special researches have been assigned to the committees of the board in the interval during which the regular work of the board is delayed by the preparation of the necessary testing machinery, and during such periods of leisure as may afterward occur. Furthermore, that the investigations will be conducted with critical and scientific accuracy, and will for a while consist in the minute analysis of a limited number of specimens, and the precise determination of mechanical and physical properties, with a view to the deduction and enunciation of laws connecting them with the phenomena of resistance to flexure, distortion, and rupture. Subsequently the board will enter upon more general investigations, testing such specimens as may be forwarded to the president, or such as it may be determined to purchase in open market. Immediately upon the completion of the apparatus ordered, circulars will be published giving detailed instructions relative to the preparation of specimens for testing, and setting forth minutely the information which will be demanded previous to their acceptance.

Engineers, scientists, and manufacturers throughout the country are warmly urged to second the efforts of the commission by imparting any information in their possession. Those wishing to aid the work can procure the fullest information by addressing the secretary, Professor R. H. Thurston, Hoboken, New Jersey.

THE STRENGTH OF CEMENTS AND MORTARS.

Surgeon E. Nicholson, of Bangalore, India, says that having completed his cement-testing machine, he has made a series of experiments with a view of ascertaining what results are given by it, not only with the ordinary materials, brick, lime, and sand, but such new material as might be presented. These experiments, which have extended over a very considerable period, embraced a large range of substances, and are especially instructive in respect to hydraulic mortars and lime. He says that the addition of raw sugar (or *jaggery*) to the shell-lime mortars made at Madras has often been mentioned, but the *rationale* of its employment is generally not correctly given. By some the advantage of sugar is ascribed to its influence in retarding setting. By others it is stated that the bad qualities of fat limes may be, in some degree, corrected by sugar, as its influence is very marked in the first solidification of the mortar. Captain Smith says that mortars made of calcined shells have stood the action of the weather for centuries because of the mixture of *jaggery* in their composition. Mr. Nicholson's own experiments confirm those of Captain Smith in showing that, while some increase of strength doubtless attends the use of sugar, it is not so great as has been supposed. The beneficial action of sugar is, he considers, to be found in the greatly increased solubility of lime in the saccharine solution. While water dissolves only about one tenth of one per cent. of lime, a moderately strong solution of sugar will dissolve as much as three per cent. It is evident that the desiccation of the sugar solution will tend to strengthen mortar by allowing the lime to crystallize. Ultimately the sugar probably becomes converted into carbonic acid and water, which circumstance tends to strengthen the interior of the mortar. In the case of mortar made simply of sand and fat limes, its slight strength is due almost entirely to simple association, and it is destitute of the setting principle possessed by the mortar of soorkee and fat lime. The strongest cement tested by him is that made of soorkee and lime (soorkee being a name given to an artificial *puzzuolana* made by pounding brick or other forms of burned clay). This cement is at least four times as strong as either pure lime or lime mixed with sand. Its cost is not greater than ordinary mortar, since it can be mixed with twice its volume of sand, and its plastic nature permits of joints being made with it, consuming less than half the quantity which would be used in the case of sand and mortar; so that it becomes advantageous to use fine bricks that have fairly true surfaces, fitting each other closely. The soorkee cement answers well for plastering; and, in order to shorten the time required by the soorkee cement to set, a process has been employed by Surgeon Nicholson for preparing the clay in some way which will render it more easily decomposable when mixed with lime.—*Prof. Papen on Indian Engineering*, 1875, 61.

CONSTRUCTION OF STEEL VESSELS TO RESIST PRESSURE.

Mr. Walter N. Hill, chemist to the Torpedo Station at Newport, states that in the course of their experiments it has been found necessary to pay especial attention to the construction of strong vessels for containing liquid carbonic-acid gas. This gas at the temperature of —4° Fahr. exerts a pressure of 322 pounds to the square inch, but at 94° Fahr. its pressure amounts to 1200 pounds to the square inch. The first flasks supplied to the station by Mr. Lay (the inventor of the torpedo) were stated to have all been exposed to a test of 2000 pounds hydraulic pressure, and were supposed to be sufficiently strong for the strains that they would be called upon to bear. The flasks having burst, however, in the course of the experiments of the first day, it became necessary to thoroughly examine the methods of construction. The holders, as made by Mr. Lay, were, it seems, at the higher temperatures of the contained gas, subjected to pressures such that the strain on the iron was more than one third, and sometimes one half the possible strength of the material. The chances of flaws in the metal, and the development of weakness under strain, are too great to allow of working so close to the limit. Soft iron, in fact, is not a good material for the construction of flasks to be submitted to great strains, which often increase suddenly. Two methods were proposed in making new flasks; one of which was the construction of a flask of copper deposited by electricity, thus getting a vessel without joints. The other plan contemplated the use of soft iron, but by a mode of construction which seems to be much better than the one employed by Mr. Lay. Subsequently a new and superior process was devised and adopted to the exclusion of all others, and this was the result of the combined skill of Messrs. Matthews and Hill. Experiments had to be made in order to find out the best methods of manufacture; but eventually flasks were made to contain liquid acid which proved entirely satisfactory. These are cylinders with round heads, each cylinder being provided with one valve in the centre of one head. When in place in the torpedo, the cylinders lie upon their sides, and a tube leads from the opening controlled by the valve into the interior of the cylinder, being there turned up against the upper side, and in this way only the gas can pass out when the valve is opened. Each torpedo is provided with four cylinders, two of them seven feet long, one five, and the other four feet long. The outside diameter of each is twelve inches. They are made of the finest sheet steel, nearly one twentieth of an inch thick, in successive layers which are firmly fastened together with pure tin. The cylindrical portions of the flasks are made by rolling up a sheet of steel, of the proper length, into a cylinder. Another sheet, somewhat longer, is rolled into a similar cylinder, which is slipped half over the length of the first. A third, fourth, etc., similar cylinders are then slipped successively over and into each other until one is built up as thick and as long as may be required. The flasks in question were made in four layers. The loose shells thus put together are fastened into a solid cylinder by means of pure tin, which is melted and worked in from the inside with the aid of gas blow-pipes. The particular diameter given to these flasks is less than that which would have been adopted had not Mr. Matthews had facilities for making this size only, he having been for a number of years engaged in making similar soda-water reservoirs of sheet steel soldered with tin. There would, however, be no serious difficulty in the way of making such cylinders of any required diameter. All of the flasks furnished by Mr. Matthews were to bear 2000 pounds to the square inch, and, in addition, an extra flask was ordered to be made exactly like the other, and to be tested to destruction. This flask gave way under a pressure of 3136 pounds. The rupture consisted of the tearing of the sheets irregularly without regard to the joints. The heads and the junctions of the heads to the body were not affected. In every respect this form of holder seems to combine strength with the assurance of freedom from hidden flaws.—*Pamphlet by W. N. Hill, Newport*, 1875.

THE THRUST OF EMBANKMENTS.

Professor Boussinesq has communicated to the Royal Academy of Belgium a theoretical essay on the elastic equilibrium of masses of powder, and on the pressure of earths devoid of cohesion. These investigations bear directly upon the question of the determination of the thickness necessary to be given to a wall destined to sustain the pressure of an embankment of earth. The problems in question were first resolved approximately by Coulomb in 1873, and very many distinguished inquirers have, since his time, occupied themselves with this important subject. Most of these have assumed the following hypotheses: viz., that the wall, when it is overturned, is borne down by a prism of earth, which with the wall slides over the remaining earth and the lower portions of the wall in a direction parallel to the plane of rupture. Coulomb's solution of the question dispenses with the above hypothesis, which is, in fact, generally inconsistent with actual experience, but assumes that at the commencement of the rupture of the wall or earth there was an equilibrium existing between the friction of the components of the embankment and the pressure due to their weight. Boussinesq has, however, resolved the problem under the supposition that the embankment of earth does actually exert a pressure over and above that which is exerted by the friction, and that it is only because this pressure was superior to the resistance offered by the wall that the overturning has been able to begin; and he has determined, in general, the laws of the pressure exerted by embankments, or by any pulverulent matter in a static condition, which precedes the rupture of equilibrium. In his investigations he has considered all the pressure which can arise from, and to a certain extent depend upon, small deformations in every elastic atom of the mass. Pulverulent matter is, therefore, considered by him as another important form of matter, different from gas, solid or liquid, which under pressure evidently becomes endowed with a certain rigidity, like solids, but which, when it ceases to be compressed, becomes a fluid.—*Bull. Acad. Royale de Belgique*, 1875, 63.

PRESERVATION OF HARBORS AND ROADSTEADS.

The remarkable labors of Captain Cialdi, of the Italian Navy, relative to the theory of the movements of the water of the ocean during storms, and the effect of waves upon the transportation of material, altering the character of harbors, etc., having been previously noticed, we have now to record the appearance of a smaller work by him on the construction of the ports of the Mediterranean. In reference to Port Said, situated at the northern opening of the Suez Canal, he suggests that, instead of constructing two complete jetties, it would be better to have a large trough or opening in the longer one, in such a position that the currents thereby induced shall carry away the alluvial matter, and deposit it in another portion of the channel. Tessan, a member of the Academy of Science at Paris, having perceived the rationality of this suggestion, urged that it should be put to the trial; but it was not done, and already a great inconvenience has been felt in the filling up of the ship channel. The engineer in charge of the hydraulic works of the Canal Company proposes now to prolong his jetties, in order to regain the depth of twenty-nine feet of water; but in future years it is evident that analogous conditions will prevail, and it will eventually be necessary either to resort to dredging or to adopt Cialdi's recommendation.

In his work on the Mediterranean ports, Cialdi has sought to determine the principal dimensions of the port that shall have a given annual tonnage. His formulas permit him to calculate very nearly the development of the quays and surface of the harbor, and that of the outer harbor or roadstead. As to the mode of construction, he discusses the relative convenience of systems whose foundations have solid stone blocks or loose masses. The latter has been often employed in France, especially for the moles at Cherbourg and the jetties of Marseilles and Algiers, where, in order to oppose the formidable action of the ocean, blocks of nine hundred cubic feet have been employed. This method has the inconvenience of requiring considerable time before the mass has entirely settled. This has been avoided in the construction of the port of Dover, in England, by placing the blocks in a regular position under the water by the aid of the derrick. In his plan for developing the harbor of Civita Vecchia, one of the most important commercial ports of Italy, Cialdi proposes to combine the two systems by employing two moles and a breakwater. At present this port has a jetty arranged like the grand dike of Cherbourg, allowing two entrances, so that, according to the prevailing wind, a ship can choose either the one or the other.—13 *B*, III., 198.

THE EVAPORATION OF WATER IN STEAM-BOILERS.

A number of experiments have been made by the engineers of the Northern Railway of France on the evaporation value of the different parts of a locomotive boiler divided into five compartments. Each compartment held seventy gallons of water, and was fed from a gauged tank by a special pump. The compartments themselves comprised the fire-box and four other smaller sections of tubing, each of them three feet long, with one hundred and seventy-nine square feet of surface, while the fire-box has seventy-seven square feet of surface. The results confirm the fact, already established by Williams and by Graham, that the evaporative performance of the tube surface diminishes rapidly with the distance from the fire-box. Havrez, by careful analysis and by experimental data, establishes the following law: The quantities of water evaporated by consecutive equal lengths of tubes diminished in geometrical progression, if the distance from the source increased in arithmetical progression; from which it follows that the ratio between the quantities of water evaporated by consecutive equal lengths of tubing is a constant number. The point at which this law begins to prevail is that at which the radiation of heat from the fuel ceases, where heat is communicated to the water by conduction alone. And it appears from observations that in locomotive boilers the evaporation diminishes by nearly one half at each interval of one meter, or from yard to yard; in other words, the constant ratio is one half. For large boilers, Havrez concludes that the value of the ratio varies between 0.5 and 0.7, but for very small boilers it may fall below 0.5.—*Proceedings of Institution of Civil Engineers*, XXXIX., 398.

CARBONIC ACID FOR EXTINGUISHING FIRES IN MINES AND ON SHIPS.

The problem of the best method of extinguishing fires in coal-mines and on shipboard seems likely to have received a practical solution in recent experiments at the Torpedo Station at Newport, Rhode Island, as communicated to the *American Chemist* by Lieutenant Barber, of the Navy, who, after a careful consideration of the subject, is decidedly of the opinion that liquefied carbonic-acid gas is the only satisfactory, while at the same time perfectly efficient application.

His plan for treating fires on shipboard is to have a flask or flasks, about three feet in length and one foot in diameter, at some suitable locality on the spar-deck or elsewhere, containing about one hundred pounds of the gas in a liquid condition. From the top or upper side of the flask a small iron pipe is to be permanently fitted along the water-ways (or just under the main-deck) throughout the entire length of the ship. From this main pipe, at suitable intervals, are branch pipes at right angles to the main, passing down next the skin to every store-room and hold of the ship; so that each compartment of the vessel shall have its own pipe or pipes, reaching from its bottom to the main pipe at the spar-deck. There is to be a cock in the main pipe near the gas flask, and one in each branch pipe near the main, any one of which can be turned from the spar-deck.

On the alarm of fire the hatches are to be battened down, the cock in the branch pipe leading to the compartment where the fire is discovered is to be opened, and also the cock in the main next the gas flask. The liquid gas, which is under a heavy pressure in the flask, passes out through the pipe in the form of vapor as soon as the pressure is relieved by turning the main cock, and is driven in an instant by the great pressure behind it to the compartment to which it is admitted. Arrived at this point, and being one and a half times as heavy as air, it fills the compartment from the bottom up, without being diluted with the air, and produces intense cold by its expansion at the same time; while the pressure with which it enters forces it into all the interstices in the cargo, driving out every particle of the air, which will all escape from the top, as no compartment on board ship is perfectly air-tight. Knowing, then, the cubic contents of any compartment, and the cubic space occupied by the cargo in it, sufficient gas can be admitted to render it absolutely certain that no fire can exist there without the necessity of opening the hatches to see if the fire is out, until such time shall have elapsed as to render it perfectly safe to do so. By shutting the cock in the main pipe the remainder of the gas is kept from vaporizing until such time as it may be required.

On arriving in port, the flask is disconnected from its pipe and sent to the gas manufactory, where it can be refilled in a couple of hours, and on being returned is set up and connected in its usual place. Should no fire occur, the apparatus can remain intact for an indefinite length of time, except to see that the cocks are in working order occasionally. The liquid is entirely non-corrosive in its character, and the vapor is not injurious to any class of cargo, while it is, perhaps, the only substance that will permanently suppress the most advanced state of combustion in a cargo of coal.

Lieutenant Barber remarks that, as is well known, carbonic-acid gas is the effective substance in the "Babcock" and other patent fire-extinguishers, but in them it is produced on the spot by the action of an acid on marble dust, or the bicarbonate of soda, and the supply of gas is quite limited; and, before the machine can be used again, it must be cleaned out and re-charged. One pound of the liquid is equivalent to about eight cubic feet of pure gas; and any quantity can be carried, as already stated, and kept indefinitely for timely use.

Until lately the use of liquid carbonic-acid gas, on a large scale, has been prevented by two difficulties: first, the want of an apparatus capable of producing a large quantity in a short time and at a low cost; second, the want of suitable vessels to contain it at low temperatures. Mr. W. N. Hill, chemist of the Newport Torpedo Station, has devised an apparatus, now in successful operation, which produces forty pounds of liquid gas per hour, at a cost of only fifteen cents per pound. To contain the gas Mr. John Matthews manufactures steel flasks of about the dimensions mentioned, which weigh but little over three hundred pounds, and which have frequently been tested to two thousand pounds per square inch, hydraulic pressure. These are made of sheets of steel rolled up one within the other, the outer one being riveted, while all spaces between the sheets are filled with pure tin. Thinner flasks, consisting of only one thickness of one sixteenth of an inch of sheet steel, are made by Mr. Matthews for soda-water purposes. They are carried constantly about the city of New York, and not one, so far, has burst.

Lieutenant Barber states that Mr. Hill is about publishing a work which will give a full description of the manner of preparing the gas and of applying it; as also the method of forming the flasks and fitting them for the required application.

It is quite probable that this principle will, in time, be adopted for extinguishing fires in burning buildings, as more effective in quicker time, and involving no damage from water.—7 *D*, *May*, 395.

SUCCESSFUL SCIENTIFIC BALLOONING.

The French Society for aerial navigation decided that its programme during 1875 should consist principally of two aerial voyages with the aid of the balloon *Zenith*, containing three thousand cubic meters, the first voyage to be of long duration and the second of great altitude. The latter voyage and its disastrous consequences have already been noticed, and, in fact, so preoccupied the attention of the world that we are apt to lose sight of the importance of its predecessor, whose duration of twenty-two hours and forty minutes places it among the most remarkable voyages on record. Throughout the whole of this voyage the members of the expedition carried on, without interruption, a series of observations, and executed numerous experiments. Departing from Villette on the 23d of March, at 6.20 P.M., the balloon carried five scientists, 1100 kilogrammes of ballast, and the instruments for observation. The determination of the altitude and the direction of the route was specially allotted to Sivel, who, by means of the plumb-line and a cord of 800 meters' length, which extended to the earth and kept the balloon always in a fixed direction, was able to observe their course satisfactorily by the compass. As is well known to aeronauts, the course of the balloon was a continued series of slight ascents and descents, the highest elevation reached being about 1800 meters, and the average altitude being about 1000 meters, except during the last six hours, when the altitude averaged about 500 meters. The course described by the balloon was very nearly toward the southwest, the entire path being some 573 kilometers. By means of an apparatus invented by Penaud, they were able, from their height in the air, to determine barometrically and continuously the velocity of their horizontal movements. This instrument is formed of a graded arc, around the centre of which an alidade moves. The observer sights, under an angle of 30°, some object visible on the earth in the direction of the march of the balloon. When this object has passed under the line of the alidade, the latter is moved to 60°, and the same object is observed until it is exactly past the alidade the second time. Another observer has meanwhile noticed the time elapsed between the two readings. By the aid of the two angles thus observed, and knowing, in addition, the altitude by the barometric readings, it is possible to compute by a simple trigonometric formula the velocity of the balloon. These observations, executed many times, gave very precise figures, which could be verified subsequently. In the morning, as soon as the sun had risen above the horizon, the atmosphere, which was very dry, suddenly became charged with electricity, whose quantity diminished gradually with the increasing intensity of the sun's rays. During the latter portion of the journey, being in the neighborhood of the sea, the passage of the balloon from an upper to a lower current of air was made eight times successively. The lower current had apparently a depth of only 150 meters; the upper current, on the contrary, prevailed uniformly above this elevation, being always from the southwest to the north-northeast, and opposed to the lower current. In the early morning hours the temperature of the air was always found to be, at all altitudes, decidedly higher than at the surface of the ground.—13 *B*, III., 293.

AERIAL NAVIGATION.

Aerial navigation has in no country been more diligently studied and more perseveringly essayed than in France; and of those who have distinguished themselves in this line of invention Penaud is among the first. In a recent communication to *La Nature*, he gives a short sketch of the best of the various kinds of apparatus for mechanical flying. He states that the war of 1870, by its stimulating ballooning, has also turned the thoughts toward the brilliant future that possibly exists for artificial flying; and he hopes that France, which has given the balloon to the world, *will also*, in the end, put to shame the ridicule of those who disbelieve in artificial flying machines. These, as at present known, are classed under the three heads of helicopters, or the helix bird, aeroplanes, and orthopteres. The helicopters are sustained in the air by the aid of helices, whose axes vary a little from the vertical; their movement of translation may be brought about either by helices suspended from the others, or by the aid of special propelling helices. The orthopteres are surfaces, very nearly planes, inclined at a small angle to the horizon, and pushed horizontally by propellers which are in general helices. Finally, orthopteres have, as their principal organs, surfaces which have movements very nearly vertical, and frequently alternating; and under this latter system are classed the wings of birds, surfaces having movements like the tails of fishes. Among the many descriptions which he gives of the special inventions included under these heads, he says that the first helicopter was that of Launoy and Bienverin in 1784. The instruments of this class invented by himself, and finally brought to perfection in 1871, would, when started in a horizontal position, at first descend slowly, then, with the velocity thus acquired, would rise, and describe a regular path at seven or eight feet above the ground, over a course of one hundred and fifty feet, enduring about eleven seconds. Some models have even maintained themselves thirteen seconds in the air, and described a path of two hundred feet, being as free as birds from all communication with the ground during their flight. The construction of the mechanical bird presents far more serious difficulties than the construction of the helicopter or the aeroplane. Marey, whose abundant researches on the subject of flight, walking, running, etc., are well known, constructed artificial insects in 1870, which rose and turned by means of their wings, but were assisted by compressed air driven from a force-pump. The improvements that were made in the following two years were remarked upon at the meeting of the Society for Aerial Navigation, in June, 1872, when two pieces of apparatus were presented, the one by Penaud, the other by Hureau de Villaneuve. A bird constructed by the latter had a remarkable power of wing, and at each stroke one could see the body rise. Unhappily the strokes were too few, and, occurring only once for every horizontal movement of one meter, it followed that the bird slowly descended like a parachute. The bird constructed by Penaud could not ascend vertically, but moved horizontally with great rapidity, elevating itself, at the same time, by means of a railing inclined at 15° or 20°. These first models were subsequently somewhat improved, so that another bird constructed by Penaud took a long flight, in the course of which it successively elevated and lowered itself by a motion similar to that seen in the flight of many small birds. The present state of the question is perhaps best described by saying that, while we have models which show that something is possible, yet the difficulties in the way of passing from these up to such larger apparatus as is demanded in order that mankind may avail themselves of this mode of progression, are, at present, too difficult to be overcome. The helicopters and the mechanical birds seem, in fact, entirely impossible to realize upon a large scale. In Penaud's opinion the aeroplanes are our only hope.

THE ADHESION OF LOCOMOTIVES TO RAILWAY TRACKS.

M. Moschelle, engineer-in-chief of the district railway of the Jura, states that ordinarily, after having determined the total tractive force which can be produced by the adhesion of any given locomotive to the rails of the track, engineers deduct therefrom a certain proportion as being required for the locomotive itself, and treat the remainder only as available for overcoming the resistance of the tender and other parts of the train. He, however, is of the opinion that engineers make this deduction on the erroneous assumption that the friction between the wheels and the rails has to overcome the resistance of all the moving parts of the engine, while he maintains, on the other hand, that it is the steam which overcomes this resistance, the adhesion of the engine not being called upon at all. He further directs attention to the fact that, by coupling a second pair of wheels to the locomotive, so as to turn them into drivers, not only is the adhesion available for traction increased by the effect of the weight upon the other pair of driving-wheels thus brought into play, but that the adhesion formerly employed to overcome the journal friction of these wheels is no longer necessary.—*Proceedings of Institution of Civil Engineers*, XXXIX., 347.

NEW ADAPTATION OF SCREW PROPULSION.

Rear-admiral Paynter, of the British Navy, has recently presented to the Royal United Service Institution his views concerning a new adaptation of screw propulsion to naval vessels, concerning the merits and advantages of which his own experiments, as well as the opinions of all who have considered it, seem to be highly favorable. The idea was first suggested by Mr. J. Buchanan, who took out a patent for certain features of his model. Several of the engineers and large ship-builders of Great Britain having expressed to Admiral Paynter their high opinion of Mr. Buchanan's ideas, he states that he has felt himself justified in presenting the matter as an important one to the attention of navigators and ship-builders. The main feature of the improvement advocated by Admiral Paynter consists in placing the propeller of a screw-steamer amidships, or nearly so; the hull of the vessel itself being cut into for that purpose in such a way that the blades of the propeller in their revolution do not project to any important degree on either side of the hull, but do project below to an extent sufficient to take hold of the water and propel the vessel. The blades are so connected with a handle, worked by the pilot on the bridge, that they may, if necessary, be presented edgewise to the water, and thus have no effect in propelling the vessel, or may even be reversed so as to back the vessel, the shaft of the screw always maintaining the same direction of motion. The wheel which carries the blades on its circumference revolves entirely in still water in the transverse chamber, or well, built as near the centre of the ship as convenient. The bottom of the vessel for about thirty feet before and abaft of this chamber is built slightly concave, so as to enable the water to have free access to the blades of the screw as they grip the water. A vessel of forty feet beam could easily carry a twenty-foot wheel, and the wheel works at a lower speed and a less consumption of fuel in order to obtain the same results as a screw. The weight of the wheel acts as a fly-wheel to carry the engine over the dead points or centre, so that only one engine need be used on ordinary occasions. The arrangement here described gives a great gain, both in the weight of the vessel and the storage room. No matter how heavily the vessel pitches, there is nothing felt of the trouble so annoying in ordinary screw-steamers known as racing. The ship may roll and pitch in the roughest weather, without causing the blades for an instant to lose their grip in the water, or cease to exert their full power. When the wheel needs to be repaired in any way, the chamber in which it moves can be closed by sliding ports, the water pumped out of the chamber, and the parts carefully examined while the ship is under canvas.—*Journal Royal Military Institution*, 1874, 527.

UTILIZATION OF WAVES AS A MOTOR POWER.

Mr. Tower proposes a method of obtaining motive power from the motion of the waves of the ocean. A boat resting upon the ocean may be supposed to be acted upon by a variable vertical force, equal to the difference between the constant force of gravity and the vertical component of the wave motion. For example, supposing the force of gravity for three seconds one fifth greater, and for the next three seconds one fifth less than its natural intensity, and suppose that we have a weight of five tons suspended by a spring, so that the spring will continue to exert a uniform upward force of five tons, no matter how far the weight moves up and down, it is clear that during the three seconds in which gravity is one fifth more than its normal intensity the five tons' weight will virtually weigh six tons, and will thus exceed the upward force with the spring by a downward force of one ton. Similarly, when the force of gravity is one fifth less, the weight will only weigh four tons, and the spring will then exert an unbalanced or upward force of one ton. If now, during the supposed interval, the weight moves downward through one foot, and during the minus interval it moves upward one foot, it is clear that during each of these intervals it will exert a force of one ton moving through one foot; that is, one foot ton. But if, instead of one foot, it moves through ten feet, it will exert ten times the power; that is, ten foot tons. Mr. Tower finds, from experiments with the model, that the best arrangement is by putting the weight on the end of a revolving arm, whereby a centrifugal force, with the wave motion, may be utilized as well as the rising and falling motion. If the weighted arm is compelled to assume successive angular positions, so that it is always at right angles with the force, it is evident that the force will be continually acting to cause the arm to rotate. When the vessel is descending, the weight is performing the upper half of its revolution, and is consequently exerting an upward centrifugal force; and when the vessel is ascending, the centrifugal force is pushing down and resisting the vessel's ascent.—12 *A*, XI., 410.

LIQUID CARBONIC ACID AS A MOTIVE POWER.

Mr. Walter N. Hill, chemist to the United States Naval Torpedo Station at Newport, has written a paper for the Naval Bureau of Ordnance on the experiments and practice, at the Torpedo Station, with liquid carbonic acid as a motor for certain varieties of movable torpedoes.

The use of compressed air has been for some time familiar to the public; but there are several difficulties connected therewith, the principal one being its bulkiness, as large vessels must be used in order to get a sufficient amount of motive power, and torpedoes can only be driven in this manner for short distances, the air being used at a pressure of from 600 to 900 pounds to the square inch. The use of liquefied gas has the advantage that a much larger quantity of motive power can be stored in the same space; of the gases that may be liquefied, carbonic acid is the best. In the employment of this substance as a motive power for torpedoes, it becomes necessary to attach to the torpedo a reservoir containing the liquefied gas, under a great pressure, the escape of which propels the torpedo through the water. The liquefaction of the gas may be accomplished either by the aid of the pressure of the evolved gas or by means of mechanical compression. The former method has been very generally employed in scientific experiments on a small scale. Thilorier's apparatus for this purpose has the advantage of simplicity, but is troublesome and wasteful of the gas. By the mechanical processes, all the gas generated may be condensed, and at less expense, although the first cost of the apparatus is considerable. The Lay apparatus used at the Newport Torpedo Station is based on the method of condensation by the pressure of the gas itself; and the experience with this confirms the previous opinion that condensation by the use of compressing pumps is much better.

After the apparatus provided with the Lay torpedo had become unserviceable for want of repair, a second one was prepared from specifications made by Mr. Hill, in which compressing pumps were employed. The pump used in this apparatus was designed and built by the Burleigh Rock Drill Company, and is a modification of their well-known air compressor. The compressor and the generator were finished in April, 1874, and are fully described in Mr. Hill's pamphlet. The novel and most important feature of the apparatus is the supplying the gas to the compressing pump at a high generating pressure. The pump has then only to compress this gas to a moderate extent to bring it to the liquefying point. One hundred pounds to the square inch is the average pressure of the delivered gas. Suppose now the pressure of liquefaction to be 600 pounds. Then the gas must be compressed to one sixth of its bulk, whereas, if the gas had been drawn from an ordinary gas-holder at a pressure of 15 pounds, it would need to be compressed to the one fortieth of its bulk. The gain is, therefore, evidently very great, both in the saving of power and the avoidance of heat evolved by the compression. In order to test the power of the pump, it has been run at a pressure of 1000 pounds; but this is higher than is reached in actual practice. The first work with this apparatus was performed May 21 and 22, 1874, when 315 pounds of liquid carbonic acid were made in less than two working days, or about nine hours of actual pumping. Great difficulty was at first experienced in the construction of flasks for holding the condensed acid. The cost of making the liquid was estimated to have been, in one case, 24.92 cents per pound, and in another case 21 cents per pound. Probably, under more favorable circumstances, the cost would not be greater than 15 cents per pound. In every respect the new apparatus at the station has fulfilled all expectations. By it liquid carbonic acid can be prepared safely, rapidly, and cheaply in any quantity.—*Hill on Liquid Carbonic Acid*, 1875.

A MONSTER BLAST.

At Crarra Quarry, Cumlodden, England, one of the largest and most successful blasts ever witnessed in that quarter was fired off on Friday afternoon, February 12, the result of which was the dislodgment of upward of 30,000 tons of granite rock. A bore thirty feet long was made into the solid rock, from the end of which, running at right angles, was another bore twenty-five feet in length, making the form of a letter L (sometimes such bores extend in both directions from the main bore, making the form of a letter T). At the end of this bore was sunk another one ten feet deep, in which chamber was placed 5300 pounds of prismatic powder.

AN IMPROVED DRY DOCK.

The latest improvement in this line is the Tubular Floating Dock, made by Mr. Latimer Clark, of Leeds, England, in conjunction with Mr. John Standfield. The dock is formed by a certain number of tubes, running lengthways of the dock, which have valves on their upper and lower sides: the upper valves being for the admission of air, and connected with a valve house; the lower valves for the admission of water. On the two tubes which are placed on the outside are flanges, which are placed on the upper side so that vertical tubes can be bolted to them. On these vertical tubes is placed a tramway, together with the houses containing the air pumps and air valves. The operation of the whole is as follows: The dock being sufficiently submerged, the ship is floated over it. The water valves are then opened, and the air valves closed; the air pumps are started and air forced into the tubes, thus displacing the water and lifting the vessel. The water valves are then closed, and the dock floats without any reference to the air valves. In order to submerge the dock, the lower or water valves are opened, the air escaping by the upper air valves at the valve house until the dock is sufficiently lowered. The advantages of this dock are the cheapness with which it can be built, the great strength attained by the use of cylindrical tubes, and the great facility with which it can be moved from one place to another, as occasion may require.

THE PROPOSED FLOODING OF THE SAHARA DESERT.

A report has recently been made by Captain Roudaire, charged by the French government with the investigation of the possibility of converting the interior of Algeria into a sea, to which enterprise frequent reference has been already made in our previous *Records*. An appropriation of $2500 was made by the National Assembly of France in 1874 for the special inquiry, and a commission was selected, of which Roudaire was placed in charge. The special object was to determine carefully, by leveling, the area that it was thought could be flooded by cutting away the barriers and introducing the water of the Mediterranean.

The party left Biskra on the 22d of December, and in a few days reached the station of Chegga, the altitude of which had already been determined in 1873. The work was prosecuted with great care, and continued until April, 1875, at which time the party returned to its starting-point, after traversing a distance of 650 kilometers.

The general result of the investigation went to show that there was a superfice of 6000 square kilometers capable of inundation, embraced between 34° 36′ and 33° 51′ N. latitude, and 3° 40′ and 3° 51′ E. longitude. In the central portion the depth below the level of the sea varies from twenty to twenty-seven meters. None of the large and beautiful oases of Souf would be submerged, Debila, the lowest of all, being fifty-eight meters in altitude. In the Oued Rhir the very inconsiderable and valueless oases of Necira and Dendouga would alone be covered.

The fear had been expressed that the invasion by the sea of the Chott Melrir would produce an infiltration, and thus destroy a portion of the wells that fertilize the oases. There being a large number of the wells situated not only in the Souf, but in the region around and in the vicinity of the basin of depression, it was found that they were all, without exception, fed from a stream above the level of the sea.

It was not thought practicable to investigate the frontier of Tunis, and consequently only the western point of the Chott Rharsa could be examined. It was ascertained, however, that this chott was below the level of the Mediterranean, and that it has a decided inclination toward the Gulf of Gabes. It was also found that the deepest basins of the Chott Melrir and of the Chott Rharsa, although united by the Chott Asloudj, had no direct communication at the present time, being cut off by sand downs. The distance, however, between the two basins is but about twenty kilometers, and could be easily opened by a canal. The plan would be to fill the Chott Rharsa, and then unite it to the Chott Melrir by a section, by which the waters, in flowing through, would soon enlarge the passage to the necessary dimensions. The Tunisian and Algerian basins might be inundated successively, the time necessary for filling being notably diminished from the fact that during the first part of the operation the surfaces submitted to evaporation would be reduced by one half.

Captain Roudaire thinks the general problem of an interior sea will be solved as soon as the Tunisian portion is thoroughly investigated, its depth and the relief of the Isthmus of Gabes throughout its entire extent being necessary. This question, however, is not likely to remain long undetermined, as an Italian commission has been taking levels in that part, and the cost of the work and the possibility, in an economical point of view, of carrying out the stupendous project will be decided. One thing may be considered as fairly settled, although heretofore not of much controversy, namely, the existence of a vast depression capable of being filled with water.

THE SUEZ CANAL.

The recent report published by the Suez Canal Company, bringing up the statistics of the canal to the beginning of April of the current year, is, in more respects than one, an instructive document. It shows that the prediction of those who favored the enterprise from its inception—namely, that its opening would in a few years revolutionize the trade of Europe and the East—has been practically realized in the five years that the canal has been thrown open to traffic. It gives, furthermore, the gratifying intelligence that the success of the canal as a commercial venture is no longer a matter of doubt and uncertainty, but an established fact, while to Americans the document will afford a substantial argument in behalf of the long-deferred interoceanic canal across the American isthmus.

The canal was open to navigation in December, 1869, since which time to April 1, 1875, 5236 vessels made the transit. Of these 4998 were steam-vessels, and but 238 sailing-vessels, the small proportion of the latter being ascribed to the danger and difficulty of navigating the Red Sea; 2863 vessels passed through from the Mediterranean, and 2373 from the Red Sea.

The statistics by years are herewith given, the figures denoting a steady increase of business: 1870, 489; 1871, 763; 1872, 1082; 1873, 1173; 1874, 1264. Up to the end of the first quarter of 1875, 455 vessels had made the transit, which gives an average of 1820 for the year. If the totals above given are divided according to the nationality of the vessels represented, it will appear that Great Britain was represented by 3602 vessels; France, 416; Austria, 303; Italy, 254; Turkey, 131; Holland, 123; Egypt, 100; Germany, 95; Spain, 63; Russia, 36; Portugal, 22; Denmark, 17; Sweden, 15; the United States, 10; Belgium, 9; Greece, 7; Japan, 4; Burmah, 3; and Peru, Tunis, and Zanzibar, each 1.

In 1870 the net tonnage amounted to 436,609 tons, producing for the company a revenue of 5,048,944 francs; in 1874 the tonnage reached 1,631,640 tons, producing a revenue of 24,748,900 francs.—1 *B*, *July* 25, 231.

THE CHANNEL TUNNEL.

The recent meeting of the British Association gave an opportunity for the discussion of this gigantic project, and the current of opinion was for the most part favorable to its feasibility, so far as the geological and engineering problems involved therein are concerned. With regard to the actual undertaking of the work, it appears to be admitted on all hands, in view of its enormous cost, and consequently its doubtful character as a financial venture, that it must be made a national work, and executed under the combined auspices of the English and French governments. The legislation looking to this mutual division of responsibility has been conceded by both governments involved in the undertaking, and the reports of the joint commission of English and French government officers now engaged in studying the problem will, in all probability, decide the question as to whether the Channel Tunnel is to be a reality. Sir John Hawkshaw, the president of the British Association, and one of the government engineers of the project, in the discussion before that learned body gave the scheme his decided approval.

ELECTRICITY FOR THE HEAD-LIGHT OF LOCOMOTIVES.

A series of experiments has lately been made by the Russian government with reference to the use of electricity for the head-light of locomotives, a battery of forty-eight elements making every thing distinct on the railway track to a distance of over 1300 feet.—6 *C*, *October* 29, 1874, 438.

M. TECHNOLOGY.

XEROGRAPHY, A MANIFOLD WRITING AND PRINTING PROCESS.

By the following process, devised by Hansen, it is said that about 100, or even 200, copies of a manuscript may be taken in ten minutes. In manipulation it is similar to that with oiled paper saturated with a pigment, except that in this case the colored paper is placed beneath, with the colored side uppermost, and upon it, instead of writing-paper, a sheet of firm, thin, very dry oiled paper is laid that will take up the color without absorbing it. There may be a pile of five, or even ten, such layers of alternate colored and oiled paper, and when it is written upon with a pencil or stylus, a copy in reverse will be formed on the lower side of each leaf of oiled paper. From each of these about twenty impressions can be taken by placing writing-paper in contact with each one, and subjecting the whole to the pressure of a rolling-machine, then removing the impressions, renewing the writing-paper, and subjecting the whole to somewhat greater pressure than at first; repeating the operation with increased pressure for each impression up to the twentieth. It is only the blue paper that will afford so many impressions, and it must be thin, and the color must be much more finely ground than it is usually found in the trade. The paper on which the impressions are taken must not be rough, nor should it be too smooth, and the first impressions should be made with the least possible pressure. The printing, copying, or even the lithographic press is not well adapted to this work. If only twenty copies are desired, an ordinary pen in writing will answer.—8 *C*, *September* 17, 1874, 332.

STAMPING-INK.

An excellent stamping-ink that dries rapidly and is free from grease may be cheaply prepared, according to Müller, by dissolving one part of crystallized so-called red aniline violet in 30 parts of alcohol, and adding 30 parts of glycerine to the solution. This colored liquid is poured upon the cushion and rubbed with a brush.—5 *C*, XXXVIII., 1874, 271.

A NEW PROCESS OF ENGRAVING ON COPPER.

The Hydrographic Office at Paris has begun a process of engraving on copper which promises by its rapidity and the moderation of its price to be very widely useful. It consists, in substance, first, in covering a plate of copper with a thin shell of adhering silver, upon which is spread a thin layer of colored varnish; second, in drawing thereon, with a dry point, the lines, topography, and lettering, precisely as one engraves with a diamond upon stone; third, in corroding the traces by means of the perchloride of iron.—6 *B*, LXXVIII., 1535.

SLATE FOR ENGRAVERS.

As a matter of interest to wood-engravers, we note the reported discovery that plates of polished slate may be used in wood-engraving as substitutes for box-wood. It is declared that such engraved plates will furnish over 100,000 impressions without loss of detail; and, further, that they will not warp, and are not affected by either oil or water. The one drawback which they possess, however, is the fact that they are readily scratched; an objection from which even wood is not entirely free.

FRENCH METHOD OF ENGRAVING ON WOOD.

A French method of engraving on wood consists *in* first covering the block with a layer of gelatin (0.39 grammes to 31 grammes of water) by means of a soft brush. When this coating is dry, it is covered, in the dark, with a solution prepared of (1) red prussiate of potash, 7.80 grammes; water, 62.20 grammes; (2) ammonio-citrate of iron, 9.10 grammes in 62.20 grammes of water. These solutions are mixed and filtered, and the mixture is kept in the dark. After the layer is dry, it is exposed under a negative from ten to twelve minutes, and washed with a soft sponge, when a blue image appears. If thus prepared the coating does not shell off under the graver.—5 *A*, *January*, 1875, 98.

GOLD, SILVER, AND BRONZE INKS.

Most of the gold and silver inks on sale are so wanting in brilliancy and fluidity, and retain their stickiness to such an extent after use, that shell-gold and shell-silver are generally preferred, although less conveniently employed. According to Viedt, however, gold, silver, and bronze inks are prepared that afford beautiful results, and that flow freely, though slowly, from an ordinary steel pen, although better applied with a pencil. True gold-leaf, although undoubtedly the best for ink, is sometimes replaced, on account of its price, by mosaic gold or iodide of lead, but generally by false leaf. On account of the cheapness of silver-leaf, silver ink of inferior quality is but seldom made from false leaf, etc. Ordinary commercial bronze powders are employed for inks of other metallic tints. Besides true and false leaf, metals are to be had in the form of very fine powder, prepared from gold-beater's waste, by rubbing it through sieves. These, previous to the manufacture of ink, must be freed from fatty and other impurities derived from the skins by triturating them or the bronze powders on a glass or porphyry slab with just enough honey to form a thin paste, as carefully as possible, since the beauty of the ink depends greatly upon this operation. This paste is then boiled for some time in a glass beaker, with water rendered somewhat alkaline, and allowed to settle, and, after the liquid is decanted, the powder is well washed with hot water, and dried at a gentle heat. Different shades may be imparted to it by boiling it with water containing sulphuric, hydrochloric, or nitric acid. A sufficient quantity of the purified powder is triturated with a solution of one part of white gum-arabic, four of distilled water, and one of potash water-glass. In general, one part of metal to three or four of the liquid will answer, but less gold is required than silver, since it covers far better; and glazed paper, and paper of a dark shade, also require less metal than rough, or light-tinted paper. A stock of ink may be prepared at once, and is best kept in a shallow porcelain vessel, so that it can be thoroughly stirred before filling into smaller bottles. It is also necessary to stir frequently when using it, and it is preferable to mix the dry powder with the liquid just before using it. The water-glass plays an important part in increasing the lustre, protecting the tint from atmospheric influences, and preventing too deep a penetration into the paper, without much impairing the fluidity. The lustre can also be improved by gentle burnishing.

WRITING PIGMENTS OF ANCIENT MANUSCRIPTS.

The destruction of ancient codices and palimpsests by modern scholars has been exhaustively discussed by Hotz-Osterwald, of Zurich. He contends that modern philologists ruin the ancient manuscripts by improper reagents, or injudicious use of them, and asserts that, with the exception of the carbon inks employed on papyrus, the writing pigments of antiquity and the Middle Ages have scarcely been investigated. The dark to light-brown pigment universally used on parchment, hitherto a problem, he contends, upon historical, chemical, and microscopic evidence, is identical with œnocyanin, and was prepared for the most part from yeast, and was first employed as a pigment. Contrary to the general opinion, it contains no iron, except frequently simply accidental traces. After its appearance in Greece in the third century, it formed almost exclusively the ink of the ancient manuscripts, until displaced in the fourteenth century by the gallate inks, undoubtedly introduced by the Arabians. The reagents usually employed upon manuscripts are without exception either wholly or partially objectionable. First of all the well-known "Gioberti-tincture" (yellow prussiate of potash and hydrochloric acid) soon converts both ink and parchment into a blue powder. The metallic sulphides, generally pronounced perfectly harmless, also cause the writing to wash, and often render it illegible in a short time. On the other hand, yellow and red prussiate of potash with acetic acid are recommended, and it is said that successive treatment with solutions of them may be of service with most perplexing palimpsests. Sulpho-cyanide of potassium, however, although theoretically the best, when used with acetic acid causes such decided contraction of the parchment as to be useless in this way. The destruction of many old manuscripts, ascribed to the monks, he feels satisfied has been due to the physical properties of the papyrus, especially its attraction for moisture.—13 *C*, *March* 1, 1875, 321.

TO RESTORE OLD WRITING.

To restore writing upon parchment, or paper, which may have become faded or illegible by time, it is recommended to first go over the surface with a sponge and warm water, then to pass over the written parts with a pencil moistened in a weak solution of sulphide of ammonium, which in the majority of cases will at once restore the legibility of the text. The success of the process depends upon the fact that the great majority of such old writings will be found to have been made with an iron ink, and the action of the sulphide consists in the production of a sulphide of iron with the traces of iron yet remaining thereon.

AN OIL-LAMP AS A SUBSTITUTE FOR THE MAGNESIUM LAMP IN PHOTOGRAPHY.

Van Tenac exhibited, in Paris, an oil-lamp with a burner so constructed as to admit a jet of oxygen directly into the interior of the flame. The light produced was perfectly steady, and so intense that the gas-flame appeared yellow by contrast. Although less actinic than the light of the magnesium lamp, it is suggested that, by reason of its uniformity, cheapness, and convenience of use, it may be employed by photographers for reproductions which need not be produced rapidly.—15 *C*, VI., 1875, 96.

COMPOSITION FOR NON-ACTINIC (AMBER-YELLOW) GLASS.

A yellow glass, suitable for photographic dark-rooms, that is said to be more beautiful, purer, and more brilliant in color than that colored with metallic oxides, can be made by employing dried cow's-dung as the coloring matter, in the proportion of one part by weight of the dried and sifted dung to sixty parts of the usual mixture for colorless glass.—13 *C*, *March* 1, 1875, 318.

ADVANCES IN PHOTOGRAPHY.

In a review of recent discoveries in photography, Meldola states that since the year 1842, when Becquerel photographed the whole solar spectrum, and Dr. Draper the violet, blue, and ultra red, no successful attempts have been made to photograph the red end of the spectrum. Becquerel's result was obtained by a film of silver iodide first exposed to diffused light, and then to the action of the spectrum, by which processes he was able to photograph the entire spectrum from the ultra violet to the ultra red. During the past year Dr. Vogel has demonstrated that, by varnishing the ordinary bromide of silver plates with a dye of coralline we get the maximum of photographic action in the indigo and the yellow; and by using aniline green the maximum of activity in the indigo and red. Again, Becquerel has dissolved coralline in the iodized collodion film, and obtained similar results. The most remarkable action was observed in the case of chlorophyl, by the use of which a spectrum image of great length was obtained from the ultra violet to the green, with a weaker impression from the green to the red. Continuing these observations in connection with what has more recently been published by Lockyer, we find every reason to announce, as a probable law, that the optical observation of the bands of any chemical show the active rays for that chemical; and that therefore, by a proper selection of dyes, a sensitive plate may be prepared especially adapted to any or to all operations on the spectrum.—12 *A*, X., 282.

IMPROVEMENT IN THE MANUFACTURE OF STUCCO.

A stucco has recently been prepared as follows, under the name of French or English cement, which becomes unusually hard when slowly worked with water, and which, when mixed with pigments, as lampblack, ochre, etc., after complete hardening, can be polished to resemble marble: Gypsum, after having been calcined once, is immersed for a few minutes in a 10 to 12 per cent. solution of alum. Chemical analysis shows that the plaster thus prepared is exceedingly pure, and contains but little alumina or potash. The alum has been replaced very successfully by Landrin with water containing 8 to 10 per cent. of sulphuric acid, by placing the gypsum in it, after its first calcination, for a quarter of an hour, and then recalcining it. All organic matter is thus destroyed, and the plaster, besides being of most excellent quality, is pure white.—8 *C*, *November* 26, 1874, 422.

RED MARKING-INK FOR CLOTHING.

A red ink for marking clothes, which is not attacked by soap, alkalies, or acids, is prepared by Welger as follows: Enough finely pulverized cinnabar to form a moderately thick liquid is very intimately mixed with egg-albumen, previously diluted with an equal bulk of water, and beaten to a froth, and filtered through fine linen. Marks formed on cloth with this liquid, by means of a quill, are fixed, after they have become dry, by pressing the cloth on the other side with a hot iron. The ink will keep in well-closed bottles for a long time without separation of the suspended cinnabar.—6 *C*, *September* 10, 1874, 368.

SUBSTITUTE FOR INK.

A substitute for ink has been devised by Dr. Jacobsen, of Berlin, which consists of points, like the leads of ordinary pencils, that can be fitted into holders. The writing at first very much resembles lead-pencil marks, but when moistened immediately assumes a violet tint, and then adheres to the paper like ink. As many as six good copies can be taken from it by means of an ordinary copying-press.—5 *C*, LI., 1874, 449.

THE HARDENING OF PLASTER OF PARIS.

Landrin distinguished three phases in the hardening of gypsum by watching its progress under the microscope: (1) the assumption of a crystalline condition by the calcined plaster in contact with water; (2) the solution of a certain portion of the crystal by the surrounding water; (3) the evaporation of a certain amount of water by reason of the heat generated in taking up the water of crystallization and the formation of a crystal, which effects the crystallization of the whole mass, just as a crystal in a supersaturated solution of a salt. During the first two phases no hardening takes place, and it is only after some time that the maximum degree of hardness is reached, and the amount of water then present is only double that in the ordinary hydrate or gypsum. A definite mixture of water and plaster, which hardened in ten minutes, was found to lose water gradually for eighteen days, until the above composition was reached, when there was no further loss of water.—18 *C*, *Oct.* 14, 1874, 648.

SETTING OF PLASTER OF PARIS, AND MIXTURE OF LIME WITH IT.

According to Landrin, the setting of plaster of Paris is retarded by any thing unfavorable to crystallization, as by the use of a large quantity of water, in which case, however, the mass becomes very porous; or better still, by the addition of gum, glycerine, glue, etc., in making up the plaster, when the viscosity operates against crystallization. The treatment of plaster with alum and sulphuric acid, as suggested by him, and which is the most advantageous, diminishes somewhat its affinity for water, and thus causes it to set more slowly. The minimum of water can therefore be used in making it up, and, since it is perfectly anhydrous, it combines with a larger quantity of the water than the common gypsum, dries more rapidly, and becomes very hard. He also found that the caustic lime contained in plaster, resulting from the presence of carbonate in the gypsum, exercises a favorable influence upon its setting when mixed with water, since it combines with a portion of the water, producing an elevation of temperature and more rapid setting, and imparts a hardness doubtless due to its conversion into carbonate in the air. Common gypsum, containing 10 per cent. of lime, is said to give very excellent results, as it can be readily smoothed, and resists atmospheric influences better than plaster alone. Landrin has even prepared cements containing as high as 75 per cent. of lime.—13 *C*, *November* 1, 1874, 1369.

COLOR OF CHINESE BRONZES.

A chemical examination of some Chinese and Japanese bronzes of an unusually deep color, exhibited in Paris in 1869, has shown the existence of a much larger percentage of lead than occurs in the ordinary bronzes, proving that it is to this substance that the special composition and color of the bronze is due. Where zinc was present in considerable quantity, it seemed rather to counterbalance the effect of the lead. An alloy, composed of 5 parts of tin, 83 of copper, 10 of lead, and 2 of zinc, proved to be exactly like the Chinese bronze, and identical with it in fracture and polish. When heated in a muffle, it quickly assumed the peculiar dead-black appearance so greatly admired in Chinese bronzes.—21 *A*, *Sept.*, 1874, 927.

ARTIFICIAL DECORATION AND HARDENING OF SANDSTONE.

The following process of artificially impregnating sandstone is said to be in successful operation at several German stone quarries. The stone operated upon is a porous sandstone, which readily absorbs water to a certain depth, and the treatment consists in the successive introduction of a solution of an alkaline silicate and of alumina. The result is the production of an aluminous silicate within the pores of the stone, which gives to the surface a considerable power of resistance. The solutions employed are soluble glass and sulphate of alumina. After the process is completed, the stone may be polished like marble, which it greatly resembles. Heated to a high temperature, the exterior layer vitrifies, and may therefore be colored or decorated according to taste. The coloration may even be obtained by simply mixing the desired pigment with one of the solutions employed.

PRODUCTION OF PATINA, OF DIFFERENT COLORS, ON BRONZE.

The attention of Christophle and Bouilhet has been specially devoted for several years to the difference in the color of bronzes, and the method of reproducing them. Their investigations were controlled by the conclusion, reached after numerous experiments, that the patina of bronze can only be permanent when it results from natural chemical reactions, and is not developed by varnish or corroding agents. As a result, they exhibited brown, red, orange-yellow, and black colors. They state that they were obtained upon the surface by reactions which cause the production of suboxide of copper in two molecular modifications, and also of sulphide of copper. The objects allow of a coating of varnish for protection, the chief condition of its successful application being the slowness with which it is done. The process, it is claimed, is practical and trustworthy, and it will reproduce the same three colors at any time. Addition of lead to the alloy is not necessary to produce the black patina, which under such circumstances has been found to be brittle and wanting in permanence.—14 *C*, CCXIII., 1874, 447.

PÂTE SUR PÂTE, A METHOD OF DECORATING PORCELAIN.

The following is from an account of this method of decoration given by Professor De Luynes, of the Conservatoire des Arts et Métiers, Paris. A faint drawing is first made on the article, completely formed in unbaked porcelain. All the details are then represented by means of a colored mass, diluted with water to the consistency of paste. The composition of the latter must be similar in nature to that of the porcelain, and its degree of contraction must be the same, so that the subsequent heating does not cause them to separate. The oxides employed as pigments must be so refractory as to resist the temperature of the porcelain oven, and not be converted in it into colorless silicates, or a dead coloring. The selection of pigments is therefore very limited. The colored *pâte* is laid on by the artist with a brush, and he regulates the distribution by the drawing, and the manner of laying it on by the number and thickness of the coatings, according to the relation that the color of the mass and its thickness must have to each other in the finished article. The appearance of relief is produced partly by the brush, and partly by a variation in the number of coatings, and by the manner of laying them on, and may be still further heightened by the employment of an instrument with which a true relief is given. The article is subsequently subjected to all the processes of undecorated porcelain. While articles produced by this method, by the aid of some of the best artists, have been greatly admired, and although it may combine all the excellences necessary to the production of works of art, they must necessarily be very expensive, on account of the long and minute labor required of the artist, and the risk to which the article is subsequently subjected in the baking.—13 *C*, *Nov.* 1, 1874, 1368.

STARCHING LINEN.

The following is recommended by a German journal: Make a liquid paste with good fine wheat starch and cold water, and then stir in boiling water until a stiff paste is formed, and immediately add white wax, or stearin, say about one ounce of wax to a pound of starch (the exact proportions, however, in any case can only be determined by experience). If it is desirable that the linen should be very stiff, powdered gum-arabic may be added to the cold water with which the starch is mixed. The strained starch should be thoroughly rubbed into the articles after they have been well wrung out, after which they should be placed between dry cloths and passed through the mangle, and then rubbed on an ironing-board in one direction with a soft rag, to distribute any lumps of starch. Collars, etc., should be ironed dry, with a hot iron and considerable pressure. The sticking of the iron may be prevented by drawing it, while hot, over wax, and wiping it with a rag dipped in salt.—15 *C*, XXIV., 1874, 380.

PASTE FOR PHOTOGRAPHS.

Paste prepared as follows is highly recommended by Tunny for photographs: Mix thoroughly 630 grains of the finest Bermuda arrowroot with 375 grains of cold water, in a capsule, with a spoon or brush, then add 10½ ounces more water and 60 grains of gelatin in fine threads. Boil, with stirring, for five minutes, or until the liquid becomes clear, and when cold stir in well 375 grains of alcohol and 5 to 6 drops of pure carbolic acid. Keep in well-closed vessels, and before use work up a portion carefully with a brush in a dish. It is said to keep for a considerable time.—15 *C*, XXIII., 1874, 357.

MUCYLINE, A COMPOSITION FOR OILING WOOL.

The so-called mucyline, for oiling wool, consists of sebacic acid, 19.8 lbs.; potash soap, 19.8 lbs.; glycerine, 11 lbs.; sulphate of zinc, 154 grains; and water, 55 lbs. The sebacic acid is carefully mixed with the glycerine, or instead of it with a vegetable or animal mucilage, and the soap is then added. The mixture is then diluted with 10½ quarts of water at 176°, in which the sulphate of zinc has been dissolved, and the rest of the water is then added very gradually, with continual kneading of the mass. The very tough, homogeneous paste thus formed can be kept for two weeks, or even longer, and the mucyline, which is a liquid of a density 1.025, may be prepared from it, by adding to 35.2 lbs. of it 39.6 lbs. of water, either cold or warmed to 68°–77°, according to the season, and filtering the liquid or allowing it to settle.—32 *C*, *April* 10, 1875, 174.

WATER-PROOFING COMPOSITION FOR BOOTS.

A mixture made as follows is said to render leather water-proof and pliable, as well as far more durable, and at the same time does not prevent its taking ordinary blacking:

Take three parts of green cart-grease, one of lard, and half a part of common comfrey. Chop the latter quite fine, and boil to a thick paste with water, and free it from fibres by straining. If the leather is very hard, more comfrey should be taken. Before the application of the mixture, the boots should be rendered pliable by moistening them with warm water, and after they are thoroughly coated with it, especially the soles and seams, they should be allowed to dry slowly in the sun or near the stove. The operation should be repeated every two weeks, at least upon the soles and seams. —26 *C*, IV., 1875, 37.

RAPID BLEACHING OF LINEN.

According to the experience of some, time may be saved by bleaching linen by the following process: Rub the linen as it comes from the loom, in a dry condition (best on a table), with a brush, with a lather of soap made by boiling 1½ lbs. of soap for a piece of coarse linen, or 1 lb. for a piece of fine, and allowing it to cool; then cover the linen in a tub with a cloth. Prepare a lye, for a piece of linen, by boiling half a bushel of good sifted beech-wood ashes in rain or spring water, and filtering it through a lye-basket; bring it to boiling in a clean kettle, and pour it upon the linen. Cover the vessel well, so that the warmth and moisture may be retained as long as possible, and allow it to stand overnight. Spread the linen on the grass in the morning, see that no spots become dry during the day, and cover at night again with the boiling lye. Turn the linen out the second day, and expose as before, without allowing it to become dry, and steep it overnight in weak hot soap-suds in a well-covered vessel. Wash out the dissolved dirt in the morning, and expose again, without allowing it to dry before evening, and then treat in the usual way until it is as white as may be desired; six to eight days often being sufficient. If necessary, however, the soaping and steeping may be repeated as before, when only two days additional bleaching will be required.—9 *C*, *July*, 1874, 102.

RAPID BLEACHING PROCESS.

The following processes are given by the ***Muster-Zeitung***: The washed material is steeped from six to twelve hours, according to its character, in a weak bath of 5½ to 7½ lbs. of chloride of lime to 26½ gallons of water, and, after being washed, is boiled from two to four hours in a bath of 23 ozs. of soda to 26½ gallons of water. If the fibres are very firm the material is dipped, previous to boiling in the alkaline bath, in a bath containing 6½ lbs. of sulphuric acid, and then allowed to drain well. After treatment in the soda bath the stuff is washed, and immersed from four to six hours in a warm or cold bath of 5½ to 7½ lbs. of chloride of lime and 24¾ ozs. of soda to 26½ gallons of water, and then washed. Another process consists in employing a chlorine bath, containing excess of alkali, prepared by the incomplete saturation of lye with chlorine, or by the decomposition of chloride of lime by excess of alkaline carbonate. For linen, hemp, and cotton the excess of alkali should be 5 per cent.; for jute and other substances that are difficult to bleach, 25 per cent., varying with the temperature, which should not exceed 122°, the lower temperatures requiring more alkali.—26 *C*, XIII., 123.

REMOVAL OF STAINS OF NITRIC ACID FROM WOOLEN GOODS AND THE FINGERS.

The yellow stains made on brown or black woolen goods by nitric acid can be removed, when freshly formed, by moistening them repeatedly with a concentrated solution of permanganate of potash, and then rinsing with water. Yellow stains on the hands may be treated in the same way, and the dark-brown coloration produced may then be removed by treating with aqueous solution of sulphurous acid. —5 *C*, LI., 1874, 408.

CHROME-YELLOW, OR GREEN UPON INDIGO GROUND, ON COTTON.

The *Muster-Zeitung* recommends the following: Add 2.2 lbs. of sulphate of lead to 21 pints of water, and slake in it 6.6 lbs. of quicklime, and stir it well into 53 gallons of water, and allow it to clear. Mordant twice in the clear liquid, allow the stuff to drain, and, after half an hour, dye yellow in chromate of potash.—25 *C*, XIX., 1875, 150.

DYEING FEATHERS GREEN.

A German journal recommends a bath prepared by adding to a decoction of turmeric, indigo-blue, and slaked lime according to the shade desired. The feathers may also be removed, and more blue be added, if it is found desirable. They must be washed in a number of changes of water, to the last of which some cream of tartar should be added.—25 *C*, XIX., 1875, 150.

WHITENING WOOL WITHOUT SULPHUR.

In whitening wool according to the following process, the proportions given must be so modified, to suit the quality of it, that the fibres do not become harsh and brittle; the latter evil may, however, also be avoided by placing the wool, on its removal from the sulphuric-acid bath, in lukewarm water, containing a few crystals of soda. The wool is placed for an hour in a kettle containing, for 33 lbs., about 52 gallons of hot water, and 4½ lbs. of carbonate of baryta. It is then removed to a new hot bath, of the same volume, containing about 3 pints of sulphuric acid, to which a few drops of aniline-blue soluble in water may be added.—5 *C*, XIX., 1875, 152.

COLORING COPPER ALLOYS AND SILVER A DEEP BLACK.

According to Paul Weiskopf, any alloy of copper, or silver alloyed with copper, may have a deep black, permanent film, that will endure polishing with leather and oil, formed upon it by rubbing it hard with the tip of the thumb slightly moistened with deliquesced bichloride of platinum. The process may be considered inexpensive, in spite of the price of the bichloride, since so little of it is required, and the manipulation is so simple.—14 *C*, CCXV., 1875, 470.

PURIFICATION OF HYDROCARBONS EMPLOYED IN DRY OR CHEMICAL CLEANING.

Dr. Vohl, of Cologne, contends that the purification, with sulphuric acid, of benzol, etc., that has been employed for cleaning garments, is not to be recommended, since sulphurous acid is formed by the action of the organic matter, and this is taken up by the hydrocarbon, and may injure the color, and even the fibre of linen and cotton, in its subsequent use, unless it is removed by an alkali. Besides, an alkali, or alkaline carbonate, is the proper reagent for the removal of the fatty acids that form a portion of the impurities removed from the garments. He suggests, therefore, treatment of the impure liquid first with dilute soda solution, and then distillation with steam in a peculiarly constructed apparatus, which he describes, which acts continuously, and with which from 2000 to 2500 quarts can be purified in twelve hours, dependent on the boiling point of the hydrocarbon. The distillate is desiccated.—14 *C*, CCXIII., 1874, 399.

VIOLACEIN, A NEW BLUE DYE-STUFF.

The following process has been patented by Gottheil, in England, for the preparation of a dye-stuff, which is said to afford a permanent dark-blue color with a slight copper-red lustre. Products resulting from the distillation of tar are stirred with enough of caustic potash to impart a slight alkaline reaction, and the mixture is then washed with water, and again distilled. The oils passing over at about 347° are then washed with a weak lye, to remove carbolic acid and creosote, and are afterward mixed with a strong solution of caustic potash, and oxidized by any of the usual methods. The dye-stuff thus produced is separated by filtration, washed, and dissolved in an acid. Caustic potash is then added to the filtered solution, and the precipitate formed is washed in alcohol, and finally dried. It is entirely insoluble in alkalies, alcohol, or soap solution, but forms a red solution with dilute acids.—6 *C*, *March* 25, 1875, 118.

STAMPING-INK, FOR COTTON AND LINEN, UNAFFECTED BY CHLORINE.

An ink suitable for marking cotton and linen goods, that are to be bleached, may be prepared by diluting one part of coal-tar with one of benzine, and stirring in one tenth of a part of lampblack, until a homogeneous mass is formed. It should be dried after stamping, and may be rendered thinner or thicker by varying the quantity of benzine. — 24 *C*, XVI., 1875, 124.

DYEING HORSE-HAIR.

Horse-hair may be dyed as follows: *Brown:* The hair must first be thoroughly cleansed by placing it in a soap bath, heated to 133°, for twenty-four hours, and moving it about frequently. It must then be allowed to lie for twelve hours in a dye bath, prepared from a decoction of logwood with lime-water at 122°, and then be rinsed and dried. *Blue, inclining to violet:* The hair must first be dyed brown, as just given, and then passed through water, to which a little of a solution of 10½ ozs. of tin in 35½ ozs. of hydrochloric acid has been added, and then washed as in the previous case. *Blue:* The hair must be prepared in a solution of two parts of alum and one part of tartar, wrung out, and passed into an indigo bath, prepared with fuming sulphuric acid, and then rinsed and dried. *Red:* The hair must be prepared by placing it for half an hour in a tin salt bath, prepared like that for violet blue; after wringing it out it must be dyed with Brazil-wood, to which some alum has been added, allowing it to remain in the dye-bath for twenty-four hours, and then rinsing and drying it.—5 *C*, XLVIII., 1874, 384.

NEW BLACK PRINTING COLOR.

According to Knaffl, if vapor of turpentine is passed over sesquioxide of iron (*Colcothar vitrioli*) at a red-heat, a black pigment results, surpassing printing-ink in softness, lightness, and depth of color, and said to be adapted to printing from stone, copper, and steel.—13 *C*, *November* 1, 1874, 1370.

NEW AND DURABLE COLORS.

Durable colors can be prepared economically, according to *The English Mechanic*, by mixing small portions of sulphate of iron, nitrate of manganese, and nitrate of cobalt or sulphate of copper with a solution of sulphate of zinc. The mixture is then reduced to dryness, and subjected to sufficient heat to drive off the sulphuric acid. The colors prepared by this process are yellows, greens, grays, pinks, and gold.—19 *A*, *October* 16, 1874, 118.

IODINE GREEN ON WOOLEN YARN.

According to the *Deutsche Färber-Zeitung* the mordant for iodine green on woolen yarn is prepared by adding 40 lbs. of purified hydrochloric acid and 50 lbs. of hyposulphite of soda to 225 lbs. of soft water, and allowing it to settle. For 20 lbs. of wool, 40 lbs. of this mordant is heated to 158°, and the yarn is well worked in it, with constant turning for half an hour, and is then wound out, and the bath is again heated to 158°, and the yarn worked in it again for the same length of time, and removed, and well cooled and allowed to lie overnight. It is to be rinsed shortly before dyeing, which is done according to sample, in a clear bath, by means of iodine and picrine, wooden vessels being employed throughout the whole operation.—26 *C*, XVI. 1874, 155.

IMPROVED CHROME GREEN.

Practical chemists have, for a long time, had their attention directed to the problem of manufacturing permanent greens, otherwise than as combinations of arsenic; and it is now announced that a very fine and intense chrome green can be prepared by heating a mixture of equal parts of sulphur and bichromate of potash to redness in a crucible. The product is then to be leached with hot water, which dissolves the sulphide and sulphate of potassium produced, and leaves the oxide of chromium as a fine powder of an intense green color.—18 *A*, *October* 16, 1874, 118.

BEHAVIOR OF ANILINE COLORS TOWARD INFUSORIAL EARTH.

According to Böttger, after shaking an alcoholic solution of any aniline color with a sufficient quantity of infusorial earth, and then adding some water to the mixture, and bringing the whole upon a paper filter, the filtrate will be found to be perfectly colorless, the coloring matter being retained by the earth.—15 *C*, XVI., 256.

NEW DYES OF CROISSANT & BRÉTONNIERE.

A very important advance in the art of dyeing has been made by the discoveries of Messrs. Croissant & Brétonniere. These consist in the treatment of certain organic substances, such as wood, sawdust, lichens, moss, gluten, starch, sugar, tannin, gelatin, blood, horn, soot, sundry acids, and alkaline solids, resins, etc., by means of certain sulphides, at a more or less elevated temperature. The process of manufacture is very simple and inexpensive, according to Messrs. Wirth & Co., at Frankfort-on-the-Main, not exceeding $10 per hundred pounds; the profits being much greater than those from the manufacture of aniline colors. The new dyes comprise shades of brown, yellow, and gray; some tints of lilac and violet, and a color very nearly approaching black. They are not very brilliant compared with aniline dyes, but have a peculiar warmth of tone which makes them especially suitable for fashion colors. In combination with the wood and extract colors, as well as with the aniline dyes, very beautiful new shades are obtained. They are generally of much greater intensity than most natural dyes, and they are soluble in water, and adhere to the fibre without any mordant, although they are usually fixed by bichromate of potash. They surpass in durability any known dyes, being not in the least affected by either strong acids or alkalies.—1 *A*, *October* 9, 1874, 170.

ANTISEPTIC AND PHYSIOLOGICAL EFFECTS OF SALICYLIC ACID.

Investigations by Professor Kolbe indicate that salicylic acid, like carbolic acid, restrains or even prevents fermentation and putrefaction, and possesses general antiseptic properties. Thus the addition of $\frac{1}{1000}$, or even less, of the acid to a solution of grape-sugar, prevents entirely the action of yeast upon it. A very slight quantity added to milk keeps it sweet for a long time, without being perceptible to the taste. Fresh meat treated with it has been found to keep well in the air for weeks, and its possible use in the preservation of meat is suggested. Experiments made in the Leipsic Hospital, by strewing it, either alone or mixed with starch, upon contusions and cancerous surfaces, showed that it destroys the fetid odors without producing perceptible inflammation. Likewise in amputations and in other cases it was used with such results as to justify the hope that it may be found in surgery to have all the desirable properties of carbolic acid without its objectionable ones, and that it may also be found efficacious as a remedy in certain classes of diseases. Experiments with it by administering it internally, or by external application, in cases of incipient cholera, are suggested. —14 *C*, CCXIII., 1874, 165.

IMITATION OF WALNUT.

The following is said to be a very superior method for staining any kind of wood in imitation of walnut, while it is also cheap, and simple in its manipulation. The wood, previously thoroughly dried and warmed, is coated once or twice with a stain composed of one part, by weight, of extract of walnut-peel, dissolved in six parts of soft water by heating it to boiling, and stirring. The wood thus treated, when half dry, is brushed with a solution of one part, by weight, of bicarbonate of potash in five parts of boiling water, and is then allowed to dry thoroughly, and is to be rubbed and polished as usual. Red beech and alder, under this treatment, assume a most deceptive resemblance to American walnut. The color is fixed in the wood to a depth of one or two lines.—15 *C*, XX., 1874, 313.

ON PAINT AS AN ENGINEERING MATERIAL.

In a paper on this subject read before the Society of Engineers by Mr. Ernest Spon, the author remarked, in reference to the composition and characteristics of the pigments usually employed, that white-lead should be of good quality, and unmixed with such substances as chalk, sulphate of lead, and sulphate of baryta. Zinc white he considers not so objectionable as white-lead, but proves to be dry under the brush and takes longer in completely drying. Red-lead is durable and dries well; but antimony vermilion is capable of being substituted to advantage for red-lead. Black paints from the residual products of coal and shale-oil manufacture and oxide of iron paints are generally used for iron work, for which purpose they are peculiarly suited. He concludes, upon the whole, that no better protection for iron-ore structures can be had than oxide of iron paints. The real value, however, of any paint depends upon the quality of the oil, the quality of the pigment, and the care bestowed on the manufacture. The superiority of most esteemed paints is due to this process rather than to any process or material employed in the preparation.—*Iron*, *May* 8, 1875, 587.

VARNISH FOR IMITATING GILDING ON BRASS AND BRONZE.

A beautiful imitation of gilding on brass and bronze articles may be effected by means of a varnish composed of 160 grains of gum lac, 40 grains of dragon's-blood, 10 grains of turmeric, and 3320 grains of alcohol. The metal should be brushed with the varnish, in all directions, by means of a sponge, and then immediately warmed over a gentle charcoal fire. The surface at first will appear dead, but will soon resemble the finest gilding. The varnish should be kept in well-closed vessels.—5 *C*, XIII., 1875, 104.

GOLDEN VARNISH FOR LEATHER.

This varnish, employed in imparting to leather a lustre resembling that of the golden beetle, by simply brushing it on with a broad brush, according to investigations of Böttger, consists of a somewhat concentrated solution of fuchsin in an alcoholic solution of shellac.—14 *C*, CCXIII., 1874, 531.

PREVENTION OF YELLOWING OF WHITE PAINT.

Dr. Lüdersdorff, of Berlin, regarded the oil employed as the sole cause of the yellowing of white paint, when light and air are excluded; and since the oil acts simply by reason of its conversion, by oxidation, in drying, into a peculiar resin, which forms the sole binding material of the pigment, and renders the paint durable, he suggested a solution of some colorless resin as a substitute for oil in the preparation of white paint; and it was found, on trial, that a coating of white paint prepared on this plan remained unchanged in color after two years and a half. The number of resins adapted to this purpose is not as great, however, as might at first be supposed, since they must be colorless, especially for white paint, and hard enough to form a durable paint, and at the same time cheap enough, and should not require too expensive a solvent. Shellac, one of the very best in these respects, however, has the peculiarity of acquiring a reddish tint with carbonate of lead, unless it is bleached, in which form it is too expensive. Gum copal is not only expensive, but requires an expensive solvent. Rosin is too brittle, except perhaps in cases where a great degree of hardness may not be required. Sandarac, one of the hardest and least colored resins, and dammar were however found to answer. Among the solvents, alcohol and oil of turpentine alone were found of practical value, though not capable of substitution for each other; thus copal, shellac, and sandarac require alcohol, and dammar turpentine, and while rosin is soluble in ether, it will only dry rapidly enough when used with alcohol. For sandarac solution, 7 ounces of the gum, carefully freed from pieces of bark, etc., and 2 ounces of Venice turpentine, covered with 24 ounces of alcohol, of a specific gravity of 0.833, are heated in a suitable vessel, with continued stirring, over a slow fire or spirit-lamp, near but not quite up to the boiling point, and the solution is completed by retaining the mixture at this temperature for an hour, with frequent stirring. The varnish can be employed immediately after cooling for mixing the paint. The Venice turpentine prevents too rapid drying of the paint, and consequent difficulty in spreading it. A weaker alcohol will not only dissolve sandarac with difficulty, but is also liable to become so dilute, by evaporation, as to cause a powdery precipitate of the gum, and prevent the formation of an adherent film. The white-lead to be used with this varnish is first finely ground with water, and dried, and then again ground with a muller with barely as much turpentine as the operation requires. The varnish will not answer for this operation, because it dries too rapidly, but the mass thus obtained is stirred with as much varnish as is necessary to form a paint that will spread readily; about one pound of white-lead being required to half a pound of varnish. As it dries quickly it must be applied rapidly, and without passing the brush over partially dry portions. In course of half an hour a second coat may be laid on. One peculiarity of this paint deserving of notice is that it thickens so much in the vessel from which it is used that it will not spread well, a difficulty that may be remedied by thinning it, not with alcohol, however, as might be supposed, but with a little of the varnish, since the thickening is not due to the evaporation of alcohol, but to a peculiar chemical action of white-lead upon the sandarac. If the color is wanting in lustre when dry, too much varnish has been employed, but a fine, agreeable polish may be imparted to it, when perfectly dry, by rubbing with a woolen rag. Paints with oil of turpentine are just as easily prepared, but the choice of resins is far more restricted, and the proportions are different from those with alcohol. Dammar is found to answer every requisite of hardness, cheapness, and freedom from color. Eight ounces of the crushed gum are heated with 16 ounces of oil of turpentine to 167° to 190°, and kept at that temperature, under continued stirring, about an hour, until solution is complete. The varnish is decanted on cooling, and preserved for use. The color is dead, however, even with two coats, and does not receive a polish as readily as that with alcohol varnish. A gloss may be imparted by coating it with the pure varnish, to which half its weight of oil of turpentine has been added, or better still by coating it with sandarac spirit-varnish, since sandarac is harder than dammar alone, and the article will therefore endure handling longer. The elasticity of these paints is less than that of fresh oil paints; but this quality is easily dispensed with in painting inner doors, window-frames, etc.—15 *C*, VII., 1875, 97.

KEKUNE OIL, OR HUILE DE BANCOUL.

The oil from the nuts of the *Aleurites triloba* (they contain 50 to 60 per cent.), which is found in the European market, though not regularly, under the name of Kekune oil, or *huile de bancoul*, deserves, according to Dr. Wiesner, more notice from oil manufacturers, not only on account of its cheapness (as it can be produced in large quantities in Guadaloupe, New Caledonia, etc.), but also on account of its quality. It belongs to the drying oils, and is said to be remarkably well adapted to the preparation of oil paints, and if it also prove adapted to the manufacture of printing-ink, at less cost than that from linseed-oil, its introduction for that purpose will be very desirable.—6 *C*, *July* 30, 1874, 308.

OIL FROM THE CARAPA-TREE.

Attention has lately been called to the commercial value, for oil-producing purposes, of the Carapa-tree (*Carapa guyanensis*). This plant abounds in French Guiana, especially in the district of Cachipour, where it forms vast forests. The fall of the nuts extends from February till June, and they are so abundant that the soil for many leagues in extent is covered with them to a depth of several inches. If collected and pressed during this period, they yield about 35 per cent. of an excellent oil. The price at Cayenne is estimated at about $25 to $30 per ton.—17 *A*, *October* 1, 1874, 151.

VASELINE, A NEW PETROLEUM PRODUCT.

A new petroleum product has been introduced into the trade under the name of Vaseline, which, according to *The*

English Mechanic, promises to be useful as a vehicle for emollient preparations. It is a solid, semi-transparent jelly, free from taste or odor, and becomes liquid at 93° Fahr. It is obtained by evaporating crude petroleum, and filtering the residue through animal charcoal.—18 *A*, *Sept.* 25, 1874, 36.

TINNING VARIOUS METALS IN THE HUMID WAY.

The following method is given by Wegler: A solution of perchloride of tin is first prepared by passing washed chlorine gas into a concentrated aqueous solution of tin-salt, and expelling the excess of chlorine by gently warming it, then diluting it with eight to ten times its volume of water, and filtering it, if necessary. The article, well pickled in dilute sulphuric acid, and polished with sand and a steel scratch-brush, and rinsed with water, is loosely wound with a zinc wire, and immersed for ten or fifteen minutes, at the ordinary temperature, in the dilute solution of perchloride of tin. When tinned in this way, it is rinsed, brushed with a scratch-brush, dried, and finally polished with whitening. This applies to tinning cast iron, wrought iron, steel, copper, brass, lead, and zinc.—13 *C*, *November* 1, 1874, 1368.

GILDING GLASS.

The following process for gilding glass has been patented by Professor Schwarzenbach: A filtered solution of perfectly pure chloride of gold, in boiling water, is diluted until twelve cubic inches of the liquid contain one grain of metallic gold, and is then rendered alkaline with caustic soda. As a reducing agent, alcohol saturated with marsh gas, and then diluted with its volume of water, is employed. One and a half cubic inches of this liquid are added to the alkaline gold solution, and the mixture then poured between the plate to be gilded (previously well cleansed) and a glass plate placed about one tenth of an inch below it. After remaining undisturbed from two to three hours the gilding is complete, and the glass is removed and washed.—16 *C*, *November* 26, 1874, 428.

NEW PHOSPHOR-BRONZES.

Dr. Kunzel, whose name will be recalled as the joint discoverer, with M. Montefiore-Levy, of the well-known phosphor-bronze, now announces the additional discovery that when phosphor-bronze is combined with a certain fixed proportion of lead, the phosphorized triple alloy, when cast into a bar or bearing, segregates into two distinct alloys, one of which is hard and tough phosphor-bronze, containing but little lead, and the other a much softer alloy, consisting chiefly of lead, with a small proportion of tin and traces of copper. The latter alloy is almost white, and, when the casting is fractured, it will be found nearly equally diffused through it; the phosphor-bronze alloy forming as it were a species of metallic sponge, all of whose cavities are occupied by the soft metal alloy segregated from it. This phenomenon of the segregation into two or more alloys, of combinations of copper with tin and zinc, has long been known, and from the fact that such separation is generally massive, and not equable throughout the mass, it has been a source of great annoyance to the founder. Dr. Kunzel, however, seems to have succeeded in causing the segregation to take place in uniform distribution throughout the casting, and has taken advantage of the properties of the product which he obtains in this manner to construct therefrom bearings of railway and other machinery.

In heavy bearings, such as those for marine engines, the valuable properties of Babbitt metal, and similar anti-friction alloys, are well recognized; but these being generally soft, are open to the grave objection that where they are subjected to considerable pressure, or even moderate pressure accompanied by continued vibration, they become distorted in form, and then fail to sustain the journals in their proper places. The device is, therefore, resorted to by the machinist of casting a hollow cage of hard metal, of proper form, for the intended bearing, the cavities of which he then fills by casting into them the soft metal alloy, which thus forms the actual rubbing surface of the bearing. The hard metal cage supports the soft metal within, and prevents its distortion or escape, save by surface abrasion. Dr. Kunzel claims to effect the same result by the peculiar constitution of his new phosphorized alloy for bearings. This forms its own supporting cage, for the soft bearing metal, which, as alluded to at the outset, separates from it in the progress of cooling. He claims that these bearings combine the very small friction and non-abrasion of the journals, with the firm resistance to pressure and stability of form of bearings of hard metals. The test of practice alone can decide the value of these claims, though they seem very plausible.—3 *A*, *October* 24, 1874.

A NEW SILVER-LIKE ALLOY.

A new and inoxidizable alloy, resembling silver, has lately been patented by Le Marquand, of Paris, and has the following composition per kilogramme:

Pure Copper	750	grammes.
Nickel	140	"
Black oxide of Cobalt	20	"
Tin in drops	18	"
Zinc	72	"

These different ingredients are to be melted together in a crucible.—9 *B*, *May* 6, 208.

PLATING WITH ALUMINIUM.

The following process for covering metal surfaces with aluminium is recommended by J. A. Jeancou: Dissolve any desired quantity of a salt of aluminium, such as sulphate, chloride, nitrate, cyanide, etc., in distilled water, and concentrate the solution to 20° Beaume (at 50° Fahr.) in a vessel suitable for holding the article to be plated. The battery to be used should either be four pairs of Smee's or three of Bunsen's, with the elements connected for intensity, and a plate of aluminium attached to the positive pole. The solution should be slightly acidulated with its appropriate acid, heated to 140° Fahr., and kept at that temperature during the operation.

MANUFACTURE OF STEARIC ACID.

In order to facilitate the removal of the oleic acid in the manufacture of stearic acid, Deisz suggests the addition of 20 per cent. of bisulphide of carbon to the mass before pressing, since but one pressing in the cold will then be required to remove the oleic acid thus diluted, and the bisulphide can easily be removed by distillation. The process is, however, considered objectionable by Professor Heeren, on account of the unavoidable loss of bisulphide, as well as the injurious action of its vapor upon the operatives. He regards the idea, meantime, as a good one, and thinks the substitution of some less volatile and injurious liquid (as petroleum naphtha) for the bisulphide is well worth trying.—15 *C*, XVII., 1874, 272.

GAUDIN'S POLISHING PAPER.

Messrs. Gaudin & Co., of Paris, have recently introduced a new polishing paper, made with a mixture of silex and alumina melted together and reduced to a fine powder. This they claim is much superior to emery paper or any other substance used for the same purpose. It really constitutes an artificial emery or corundum, but is in a form much more convenient for application than the natural substance.—1 *B*, *May* 2, 61.

PREPARATION OF ABSOLUTE ALCOHOL.

Professor J. L. Smith informs us that alcohol of 98 per cent. can be obtained by shaking up the strongest commercial alcohol with freshly burned lime in a tightly closed vessel, renewing the operation every day for a week or ten days, when the bottles are allowed to remain at rest for a few days for the hydrate of lime to settle, and the original alcohol can be drawn off, free from lime, and of 98 per cent. To obtain absolute alcohol the last draft is to be put into a convenient flask, with the addition of lime in coarse powder and an inverted Liebig condenser attached, so that the alcohol will run back into the flask when condensed. This is then distilled over, and will mark 100 per cent.—1 *A*, *November* 20, 1874, 235.

FILLING HOLLOW BRASS ARTICLES WITH MOLTEN IRON.

Atkins, of Birmingham, casts molten iron in hollow brass objects, without danger of melting them, by simply immersing them in water, which prevents their temperature from rising above 212°. To make weights in this way the brass shell is imbedded in iron filings instead of water.—13 *C*, *November* 1, 1874, 1364.

CEMENT FOR MARBLE AND ALABASTER.

It is said that the point of fracture of articles cemented with the following mixture is difficult to find, and that the cemented place is much stronger than the material itself: Form a thick paste with water-glass (silicate of soda) by adding as much as may be necessary of a mixture of 12 parts of Portland cement, 6 of slaked lime, 6 of fine sand, and 1 of infusorial earth. The article to be cemented need not be heated. It hardens in twenty-four hours.—18 *C*, *December* 23, 1874, 815.

CEMENT FOR MARBLE WATER-TANKS.

In the Berlin Polytechnic Society, water-glass with marble-dust, glycerine, and litharge was recommended as a cement for water-tanks of marble slabs, with the statement that it was unaffected by hot water. A mixture of 12 parts of cement, 6 of whitening, 6 of fine sand, and 1 of infusorial earth, stirred to a paste with water-glass, was also mentioned for the same purpose.—34 *C*, XXIII., 1874, 183.

RENDERING IRON WIRE OF A SILVERY WHITENESS.

To make iron wire of a silvery whiteness it is first treated in a hydrochloric acid bath in which a piece of zinc is suspended. The corroded wire is then brought in contact with a plate of zinc in a bath in which 2 parts of tartaric acid are dissolved in 100 parts of water, with further addition of 3 parts of tin salt (stannous chloride) and 3 parts of soda.

The wire is allowed to remain some two hours in the bath, and is made bright by polishing or by drawing in the drawing-plate. By this galvanized tinning it is quite easy also to whiten wire which is already rolled up spirally, or iron objects of any other form, which gives an advantage over the mechanical method by which the wire is tinned at a high temperature, and then passed through the drawing-plate.—21 *A*, *July*, 672.

VULCANIZING OF CAOUTCHOUC AT COMMON TEMPERATURES.

The following process devised by Gaulthier de Caulbry is claimed to effect this object. If an intimate mixture is made of flour of sulphur and dry chloride of lime, a decided odor of chloride of sulphur will shortly be noticeable, while simultaneously the temperature of the mixture is appreciably elevated, and the mass becomes plastic by the softening of the sulphur. If a mixture of this kind, in which the sulphur is in great excess, is added to caoutchouc softened in bisulphide of carbon, it effects the change called vulcanization at ordinary temperature, or upon slight warming. When the mixture contains an excess of the chloride of lime, the mass does not become pasty, but remains pulverulent.—*Scientific American*, XXXII., 374.

CAUSTIC SODA AND POTASH.

Grüneberg & Vorster have patented in England a new process for obtaining the caustic alkalies. The chloride of sodium or of potassium, as the case may be, is mixed with hydrated alumina, and the mixture subjected to the action of superheated steam.—14 *C*, *February*, 382.

GLASS MANUFACTURED FROM SULPHATE OF SODA, OR CALCINED GLASS.

Dr. Guhrauer calls attention to the fact that, although sulphate of soda can not as yet be employed in the manufacture of a colorless glass suitable for glass vessels, it is extensively used in France, Belgium, and Holland to furnish the alkali in the manufacture of mirror-glass, although it has too decided a tint when even less than an inch in thickness to be used for half-crystal ware, etc. The process by which a glass suitable for the special purpose mentioned is made from sand, lime, sulphate of soda, and charcoal alone, rests upon the previous calcination of the glass mass, or the preparation of what may be called a finely divided, calcined glass; this is accomplished by allowing the barely fused mass to flow suddenly into cold water. After thoroughly drying this it is again fused, with the addition of broken glass, decolorizing and purifying material, as binoxide of manganese, nitre, etc.; but the desired degree of freedom from color depends in a great measure on the careful selection of the raw material, and the proportions in which the ingredients are mixed. Any furnace, upon any system of heating, will answer, and the glass, when in a very viscid condition, may be simply run off through openings, closed by valves through which water circulates, into tanks filled with water, from which it is then taken and dried, and re-fused. The consumption of time and fuel, by reason of the double fusion required, is not necessarily much, if indeed any, greater, while there are the advantages of cheapness of material in the sulphate of soda and of quality in the glass, since it may contain much less alkali. The number of furnaces need not necessarily be increased, as the same furnace may be used for the different operations. — 14 *C*, CCXV., 1875, 358.

THE MICROSCOPIC STUDY OF FIBRES USED IN THE FABRICATION OF PAPER.

The study of vegetable fibres has already occupied many observers; and the classical memoirs of Aleau and Vetillart are well known. These researches have generally had for their object the application of vegetable fibres to the textile arts; their application to the manufacture of paper has been less fully considered, but forms the subject of an extensive work recently published by Gérard, who has especially studied those vegetable fibres that enter into the composition of the pulp of the paper manufactures. He has determined with the microscope the form, dimensions, and special characters of these fibres, and, in order to illustrate his results, has reproduced the microscopic appearances by means of photography. He states the conditions which must be fulfilled by the fibre that is to produce good paper as follows: First, with reference to the length of the fibre, he finds that the pulp styled "short refined" is composed of fibres of from 0.3 to 0.5 of a millimeter in length, while if it is from one to one and a half millimeters long, it is "long refined." Rarely does it surpass this latter length; and as there is no vegetable fibre that he has examined which is not at least equal to this latter length, he concludes that they are all, so far as that is concerned, proper for the manufacture of paper. Second, it is an important consideration that the fibre should be fine as well as long—in other words, the ratio of its length to its diameter should be at least fifty to one. Third, the fibre should be elastic, and submit to twisting with ease. It is this that gives solidity to the sheet. On the other hand, the tenacity of the fibre is a matter of only secondary importance; as is seen if we notice that when a sheet of paper is torn the fibres themselves are never torn, but simply slide over and separate from their neighbors. According to their relative value in the manufacture of paper, he classifies the fibres as follows:

First, round fibres that can lend themselves easily to the formation of twisted cords. Those of hemp and flax are the only ones of this class. Second, round smooth fibres that do not easily form cording, such as jute, feather-grass, palm, sugar-cane, etc. Third, the materials of cellular fibrous nature, of which the only one worthy of note is the pulp obtained from the straw of rye or wheat under the action of caustic solutions. Fourth, fibrous plates, under which head he classes fibres of cotton and those extracted from wood by chemical processes, those of the agave, bamboo, etc. Fifth, imperfect material, such as the pulp obtained by the mechanical maceration of wood.—*Bulletin Hebdom.*, XVI, 69.

PREPARATION OF ARTIFICIAL CAOUTCHOUC.

A mass, said to resemble caoutchouc, and soluble in linseed oil, may be prepared by heating in an iron kettle, which should only be half filled, ten pounds of sulphur, or flowers of sulphur, and twenty pounds of rape-seed oil, with constant stirring, until the sulphur is melted and the mass begins to swell; then immediately pouring it into a mould, dusted with some kind of powder, or upon a stone slab moistened with water, when it will harden at once. Linseed oil may replace the rape-seed oil, in which case less sulphur must be taken.

USE OF THE WILD RICE PLANT IN PAPER-MAKING.

The stem of the American wild rice, *Zizania aquatica*, is now coming extensively into use as a material for paper pulp, yielding, as it does, fully as much of the raw material as the esparto, and being comparatively free from silicates. The paper made from this substance is quite as strong and as flexible as that from rags, while it is easily bleached, economical in respect to chemicals, pure in color, and remarkably free from specks and blemishes. It is estimated that one hundred thousand tons can easily be obtained from the shores of the Canadian lakes alone.—12 *A*, *September* 24, 1874, 427.

VALUE OF THE MILK-WEED AS A FIBRE-PLANT.

M. Roux calls attention to the value of the common milkweed (*Asclepias Syriaca*), so abundant along roadsides in the United States, as furnishing an important fibre, possessing numerous points of superiority over the common hemp, especially in view of the fact that it accommodates itself to more barren regions and requires no culture. Being hermaphrodite, and not diœcious, it produces on a given area a greater number of plants, and therefore the amount of textile fibre is much greater. It begins to grow toward the end of April, and flowers in July. It succeeds especially well in dry seasons. The height of its stalks is about five feet, and its pulp furnishes a most excellent material for paper.—1 *F*, *October* 15, 1874, 164.

PREPARATION OF WOOD-PASTE FOR PLATES, ETC.

The mass obtained by the following process, though brittle at first, acquires a surprising degree of firmness after gradual drying in the air, and the separate particles of wood may be firmly united and hardened by moistening three or four times, as soon as it is firm enough, with about a 5 per cent. solution of potash, and then drying it thoroughly. By substituting bichromate of potash for the potash, it may also be rendered water-proof as well as hard, and by adding different dye-stuffs, or the crude dye-woods, to the alum mordant, colored wooden plates and objects may be produced. One hundred parts of sawdust (best of soft wood) are boiled for half an hour in a concentrated solution of 100 parts of sulphate of alumina, in water, and then allowed to cool. Fifty parts of glue, dissolved in 100 parts of boiling water, are then intimately mixed with the above mass, and the whole thoroughly kneaded and subjected to a very high pressure.—34 *C*, XX., 1874, 159.

PREPARATION OF EBONITE.

The use of ebonite, one of the newer preparations of India rubber, is constantly increasing, on account of its better applicability to many purposes in the arts than its near ally, vulcanite. The two substances are quite similar, being composed of India rubber and sulphur, with some preparation of gutta-percha, shellac, asphalt, graphite, etc.; although these latter are not essential. In vulcanite, the amount of sulphur does not exceed 20 to 30 per cent., whereas in ebonite the percentage of sulphur may reach as high as 60. An increased temperature is also required for this preparation. The approved formula consists in mixing together 100 parts of rubber, 45 of sulphur, and 10 of gutta-percha, with sufficient heat to facilitate the combination. In manufacture, a sufficient quantity of this mixture is placed in a mould of a desired shape, and of such material as will not be affected by the sulphur contained in the mass. It is then exposed to heat of about 315°, and a pressure of about 12 pounds to the square inch, for two hours. This is done most readily by placing the mould in a steam-pan, where the requisite pressure and temperature can easily be kept up. When cold, the ebonite is removed from the mould, finished, and polished in the usual manner.—18 *A*, *January* 8, 1875, 818.

GLAZING PAPER BY PARAFFIN.

According to Dr. Vohl, the following process for glazing paper by means of paraffin is adapted to white and all delicate tints: Add 100 parts, by weight, of fine, washed, and dried pure white China clay, previously heated to at least the temperature of fusion of paraffin, to 24 parts of (easily fusible) melted paraffin. The clay, if hot enough, will completely absorb the liquid paraffin. Pulverize the mass, when cold, and grind in the color-mill with cold water. Add from 4 to 6 per cent. of this semi-fluid mass to the color previously prepared, and treat the dried paper as usual. The driest and dullest earth colors assume a fine glaze by this process; and for dark tints clays with a decided color may be used. The paraffin mixture may also be employed with advantage for glazed pasteboard, as it likewise renders it less liable to be affected by moisture.—6 *C*, *July* 16, 1874, 265.

POLISHING-CLOTH FOR BRASS.

A sort of linen was exhibited at the Vienna Exposition which served the purpose of cleaning and polishing brass very well, and was at the same time cheap enough for general use. Investigations by Dr. Reichardt indicate that the effect is due to the presence of silicic acid and an alkali, and that the article may be prepared by impregnating some loose fabric, such as fustian, with a weak solution of water-glass, and then washing it thoroughly. A not inconsiderable amount of silicic acid will be retained, in a manner analogous to alumina in dyeing.—14 *C*, CCXIII., 528.

SOLDERING PLATINIZED GLASS SURFACES TO METALS.

It has been found by Dr. Rönzgen that glass can be more firmly affixed to metals by coating it with platinum, and soldering, than it can be by cement. The tinning of the platinum surface is very easily effected by means of a soldering iron and chloride of zinc. The excess of platinum coating may be wiped off with filter-paper dipped in dilute hydrofluoric acid. The glass, of course, should be carefully warmed before applying the soldering-iron. The platinum coating is said to adhere to the glass so firmly that a well-soldered piece of metal can not be removed without injuring the surface of the glass.—5 *C*, XXXIII., 1874, 264.

IMPROVED MODE OF CLOSING BARREL HOOPS.

It is claimed that the ends of hoops on barrels may be securely joined with great economy of time and labor on the following plan, devised by Cattin: A small plate of sheet-metal has two slits punched in it in such a way that the hoops may be drawn through them readily in one direction, and are prevented from slipping out by the sharp edges of the plate cutting into them. The surface is rendered smooth by a blow with a hammer on the projecting ends of the hoops.—9 *C*, *July*, 1874, 105.

UTILIZATION OF LEATHER WASTE.

While numerous processes for utilizing the offal in the manufacture of leather are in successful operation, there has been a comparatively open field respecting leather waste. At the Vienna Exhibition, leather was shown suitable for heels, toe-caps, and inner soles, prepared from leather clippings, according to a French method, by simply mixing them with some adhesive substance, forming the mass into rectangular plates on top of each other, subjecting them to hydraulic pressure, and then drying and rolling them. This article was restricted in use because it could not withstand moisture. A Copenhagen firm, however, exhibited, for the first time, an article made upon an entirely different plan. The leather scraps were first converted, in a suitable machine, into a sort of leather-wool, which was then mixed with caoutchouc and different chemical reagents, kneaded by machinery into a thick pasty mass, and formed in metal moulds, dried, and subjected to a gradually increasing pressure until it was finished, under 6000 to 10,000 pounds to the square inch. The appearance of leather is imparted to it by a light coating. Articles manufactured from this material are said to be 50 per cent. cheaper than those from leather, and can be made in the same manner, while they are also perfectly water-proof. Chemical investigation shows it to consist of about 40 per cent. caoutchouc and 60 per cent. leather.—14 *C*, CCXXIII., 1874, 81.

MANUFACTURE OF COPPER AND BRASS WIRE.

In order to produce very long strips of brass or copper, to be drawn into wire, Lavéissière & Son, of Paris, have devised a plan of cutting them from circular plates in spiral form by means of circular shears.—14 *C*, CCXV., 1875, 377.

NEW TREATMENT OF HIDES IN TANNING.

The following preliminary treatment of hides, patented by Sainte-Marie, is said to materially shorten the time required for tanning, and in the one case to afford a soft, pliable material, and in the other to render the hides more suitable for the reception of dyes. The hides, after being freed from hair and flesh by caustic alkalies, are immersed in an aqueous solution of sulphate of ammonia, 6 to 11 pounds to from 800 to 1000 quarts of water, or in a solution of 11 pounds of sulphate of ammonia, and 22 pounds of sulphate of soda, in 800 to 1000 quarts of water.—15 *C*, XVIII., 1874, 288.

CUTTING AND BORING CAOUTCHOUC CORKS.

By moistening the knife or borer with a moderately strong solution of caustic soda and potash, instead of water or alcohol, it is said that India rubber may be cut with as much ease as ordinary cork-wood.—9 *C*, *July*, 1874, 106.

A WRITING-MACHINE.

It is said that in Austria there exists an official Bureau of Stenography, and that a uniformity in stenographic writing is imposed upon all the profession. Usually the writing of one stenographer is intelligible only to himself. The idea of creating a universal language for stenography, independent of the caprice of the operators, is claimed for various persons. As long ago as 1845, Gensoul, of France, occupied himself with this problem, a solution of which was indispensable to the success of the stenographic principles of which he is the inventor. Stenographic laws have received numerous improvements during these thirty years, both by Gensoul and by his son, who continues to develop the work of his father; and the instrument referred to, as at present constructed, is a manageable piece of apparatus, very convenient and not excessively costly. Many public experiments have been made with it at various times. Entire volumes of discussions and conferences have been published, and the Gensoul machines are at present regularly manufactured. This apparatus, which allows of writing 200 or 250 words per minute (the number of syllables falling from the lips of the most voluble orator), may be described as a piano-forte, upon which there appear twelve white and twelve black keys, which may be moved with the fingers, and two supplementary keys are added, one on the right and one on the left, that are operated by the wrists. Each key produces its indications in marks, on a roll of paper, similar to that which flows in the Morse apparatus. The only difference is that the black keys give long marks, while the white keys make only points. Every time that the keys are touched the paper is automatically unrolled to the extent of one fiftieth of an inch, so that one can make, on every line of the paper, any combination whatever of twelve double signals. These signals are arranged by three groups of four each; the three groups being read from left to right, like ordinary writing. The number of signals that can be made upon each line is more than sufficient for giving a letter for every movement of the paper; and, with skill, three letters at least may be written at once. If we suppress the useless letters, such as mutes, double letters, etc., it is rare that each movement of the paper does not give a complete word. If a word has to be continued to the following line, a mark is made by a movement of the wrist keys. The manipulation of the machine demands considerable skill, for, although one can learn to read the writing in half an hour, it is necessary to have five or six months' experience in order to follow a speaker. But one good operator will amply suffice to report legislative debates, word by word, during the most complicated sittings. If two good operators be placed, with their machines separated from each other by a considerable distance, a complete control upon the exactness of the record of the debate is insured. The reading of the written band is so easy that it is given over to the printer without inconvenience, or to clerks practiced in autographic writing. The bands of paper have not so great a length as may be imagined: a sitting of one hour consuming about seventy feet of a roll whose width is four inches.—13 *B*, III., 211.

THE JAPANESE LEATHER-PAPER.

The curious leather-paper made by the Japanese, which imitates in a remarkable degree the leather of Cordova, excited much attention at the late Exposition at Vienna; but the method of its fabrication has, until lately, remained a secret in that country, whence many objects made of it have been imported, such as napkins, clothing, umbrellas, lanterns, etc., all of which have much strength and firmness. Mons. Zeppa, a member of the Oriental Society of Japan, has lately published the processes by means of which this paper is produced. The material employed is bark of the *Broussonetia papyrifera*, or the paper-mulberry. It is the same substance that the Polynesians make use of in the manufacture of certain vestments, and even for the masts of their boats, although their process of fabrication is entirely different from that of the Japanese. The cultivation of the mulberry is very simple; the roots being placed in the earth, spread and grow rapidly, attaining a length of nine inches the first year, and twenty-seven in the second. At the end of three years the plant has a height of about thirteen feet. On the approach of fall and winter the branches are removed, and cut into pieces two inches long. These are then boiled until the bark can be easily taken off with the hand. The bark is first dried in the air for two or three days, then plunged over twenty-four hours into a current of fresh water, after which, with the aid of a particular kind of cord, the two species of fibres of which it is composed can be separated. The exterior fibres are of a dark color, and are called *sara kawa*. They are employed in making paper of an inferior quality. The interior fibres have the name of *so sori*, with which the fine paper is made. These are rolled into balls weighing about thirty-five pounds each, which are washed anew in running water, in which they are allowed to soak for a shorter time than on the previous occasion, after which they are dried. Finally they are boiled in lye made from the ashes of buckwheat flour, taking care that the contents of the tubs are always kept in motion. Another washing in pure water carries away the last impurities, and the fibres are then pounded with hammers of wood for about twenty minutes. After this they are a second time rolled into balls, and finally transformed into pulp. The pulp being once obtained, rice-water is mixed with it, and a small quantity of a liquid extract from the root of the *Hibiscus manihot*, to preserve it from the attacks of insects. The subsequent treatment of the pulp is identical with that of the ordinary manufacture of paper. The leather-paper is finally obtained by the superposition of many sheets of the material, it being previously steeped a moment in an oily extract from yonoko submitted to a strong pressure, and covered with a glazing called *shellas*. Garments are made from a variety of this paper, designated under the name of *She fu*, which is drawn out into finer or coarser threads according to the quality of the tissue that is to be made. These threads are twisted between the fingers wet with lime-water, and are finally either woven singly or mixed with silk. —13 *B*, III., 322.

NEW COLORS OF CROISSANT & BRETONNIÈRE.

Great interest continues to be excited by the remarkable character of the new colors invented by Messrs. Croissant & Bretonnière, on account of their wonderful cheapness and admirable qualities. They include nearly all the tints known to the dyers (excepting red, blue, and green), with their modifications. The cost is so trifling that a hundred-weight of the dye, which will prove a substitute for logwood, costs only about seven dollars, while an equivalent amount of extract of logwood costs as many pounds sterling. In permanence, the new colors greatly outstrip those now in use. They are not affected by light, oxalate of potash, nor even by hot soda; in fact, by nothing but concentrated chlorine.

Used with other colors, they render the latter more permanent, especially alkaline preparations. The varieties of shade are not produced by mixtures, but by regulating the temperature to which the color is exposed in the course of manufacture. These colors attach themselves permanently to the fibres, by the mere evaporation of the water in which they are dissolved. They are all soluble in water, and are precipitated by mineral as well as by organic acids. They dye equally well silk, cotton, and linen.

The method of dyeing is as follows: The colors are dissolved in hot water, and the goods are steeped and turned in the solution from thirty to forty-five minutes; they are next fixed by a hot solution of bichromate of potash, in which they are left for about fifteen minutes, washed with pure water (in the case of wool and silk, to remove excess of alkali), and then placed in an alkaline bath made up with a pound of soda to forty-seven quarts of water, and washed finally with clear water.—1 *A*, *October* 16, 1874, 180.

TESTS FOR THE PRINCIPAL DYE-STUFFS IN COLORED FABRICS.

The following course of examination has been suggested by F. Fohl for ascertaining the dye-stuff employed in any particular case in producing one of the five principal colors.

I. BLUE.—Logwood, Prussian-blue, aniline-blue, and indigo are chiefly to be considered. Proceed as follows:

A. Cover a sample of the fabric, the color of which is to be tested, with citric, or dilute hydrochloric, acid: 1. Change of color to red or orange indicates logwood; 2. No change of color—either Prussian-blue, aniline-blue, or indigo. B. Immerse another sample in a solution of chloride of lime: 1. No change of color—Prussian-blue; 2. Decoloration, or a yellowish coloration—aniline-blue or indigo-blue; to distinguish between these two, place another sample in caustic soda, when decoloration, or change of color, will indicate aniline-blue, and permanence of color indigo-blue. The presence of the blue dye, indicated by the preceding tests, may be confirmed by the following reactions. *Logwood-blue* is reddened by acids, and restored by alkalies. The fabric yields a white or grayish ash on incineration—of the former color if the mordant was alum, of the latter if it was blue vitriol; and in this latter case the edge of the flame, during incineration, will also have a greenish tinge. *Prussian-blue*—on incineration the fabric leaves a residue of ferric oxide, proportioned in amount to the intensity of the color. *Indigo-blue* leaves no ash, except that of the fabric itself, which is white and light. *Aniline-blue*, like indigo-blue, leaves no ash but that of the fabric; but it is easily distinguished from it, since the color can be extracted from the fabric by alcohol, and it is distinguished from logwood by means of citric acid, which does not redden it.

II. YELLOW.—Rust-yellow, picric acid, turmeric, fustic, Persian-berries, and quercitron are the most preferable yellows. A. In order to recognize the different colors, the presence or absence of rust-yellow and picric acid must first be determined. 1. Immerse a sample in warm, slightly acid solution of yellow prussiate of potash—rust-color will be indicated by a blue coloration; 2. Immerse another sample in a solution of cyanide of potassium, picric acid will yield a blood-red coloration. B. If picric acid and rust-yellow are both absent, place another sample in a boiling solution of one part of soap and 200 of water: 1. It turns reddish-brown and becomes yellow again with an acid—turmeric; 2. It turns quite dark—fustic; 3. It is unaffected—weld, Persian-berries, or quercitron. To distinguish between these three: boil a fresh sample briskly in sulphuric acid, color of weld will disappear, of the others remains; then boil a fresh sample in a tin-salt solution, when a change of orange indicates Persian-berries, and no change, or a very slight one, quercitron. C. Annatto, if it happen to be the dye-stuff, may be detected by the greenish-blue color imparted to a sample of the fabric dipped in concentrated sulphuric acid, it being the only yellow that gives this reaction, and it is also unaffected by chlorine, which decolorizes the yellow of quercitron, turmeric, Persian-berries, and weld.

III. RED.—Cochineal, Brazil-wood, madder, saffron-carmine, and aniline-red are to be considered. A. Dip four separate samples of the fabric into boiling soap-solution, ammonia, lemon-juice, and a mixture of equal parts of tin-salt, hydrochloric acid, and water: 1. No change in any of the samples indicates madder; 2. Any change indicates the absence of madder, and the presence of one of the other four reds: *a*, thus complete decoloration by the soap-solution, especially if the color does not return, with its peculiar shade, after the fabric has been washed with water, and agitated with lemon-juice, indicates saffron-carmine; *b*, reappearance of the red color, though weaker, by this treatment—aniline-red; *c*, production of a yellowish red, or light yellow color by this treatment—cochineal, or Brazil-wood, to be distinguished from each other by dipping a fresh sample in concentrated sulphuric acid, when Brazil-wood will at once give a beautiful cherry-red color, and cochineal a yellowish-orange.

IV. GREEN.—Dyers distinguish three kinds of green: viz., those by mixture of blue and yellow, aniline-green from aldehyde, and new aniline-green from methyl-iodide. The greens by mixture of blue and yellow, although passing into disuse, may be met with. The principal ones are: indigo with picric acid, indigo with vegetable yellows, Prussian-blue with picric acid, Prussian-blue with vegetable yellows, aniline with picric acid, and aniline-blue with vegetable yellows. The blues form the foundation of these greens, and as a rule are insoluble in alcohol, except aniline-blue, while all the yellows mentioned are soluble in alcohol, so that the acquisition of a green color by the alcohol, with which a sample dyed with a mixed green is treated, indicates at once a mixture of aniline-blue and a yellow, if by a previous test the absence of aniline-green was determined. The following course serves to determine the nature of the green dye-stuff: Heat a sample of the fabric on a water-bath for a few minutes in 95 per cent. alcohol. The alcohol either becomes, 1, yellow, while the fabric becomes more and more blue; or, 2, green, while the fabric retains its color, though with diminished intensity. In the first case Prussian-blue or indigo may be present; therefore extract the fabric thoroughly with alcohol, then wash it well with pure water, and cover it with a solution of chloride of lime, whereby indigo-blue will be decolorized, but Prussian-blue will remain unchanged. The yellow may be determined in the alcoholic solution by the method previously given. In the second case aniline-green from aldehyde, aniline-green from methyl-iodide, or aniline-blue mixed with a yellow, must be considered. To distinguish between them, boil a sample of the fabric in weak hydrochloric acid, whereby decoloration, or change to yellowish, indicates the first of the three; change to rose or lilac, the second; and change to blue, while the yellow dissolves, the third; and the yellow in solution can be determined by methods already given.

V. Violet.—Common aniline-violet, aniline-violet from iodine, madder-violet, alkanet-violet, orchil-violet, logwood-violet, and cochineal-violet are chiefly to be considered. A. Immerse a sample in a solution of chloride of lime. 1. No change of color indicates alkanet. 2. Any change one of the other six. B. Immerse another sample in lemon-juice. 1. The violet becomes brighter by presence of one of the aniline violets, to be distinguished from each other, by dipping a sample in hydrochloric acid diluted with three times its volume of water, when it will become violet-blue, and after washing somewhat redder, if it is common aniline-violet; but blue, greenish, and after washing light lilac or pearl gray, if it is aniline-violet from iodine (Hoffmann, "New Parma, Primula," etc.). 2. The sample becomes red, or even yellow, in the lemon-juice. Test for the other four violets: *a.* Place a sample, after washing it on removal from a solution of chloride of lime, in a solution of yellow prussiate of potash, whereby a blue coloration (Prussian-blue), formed with the iron mordant in the fabric, employed with madder and cochineal, indicates the presence of one of them; distinguishable from each other by the fact that, if the former, the sample turns nankeen-yellow in the chloride of lime solution, and, if the latter, it is completely decolorized. *b.* Absence of the preceding blue coloration leaves orchil and logwood to be considered. To distinguish between them, immerse a sample in milk of lime, whereby a change to gray, and final, almost complete decoloration, indicates logwood; and a change to violet-blue, orchil. The preceding can also be classified by their ash: thus if it contains iron, madder and cochineal are indicated; if it is white, orchil and logwood; while the aniline violets afford no ash of their own. The testing of the ash is indeed very important, since the determination of the mordant employed—iron, alum, chromium—may point directly to the accompanying dye-stuff.—5 *C*, XXVII., 1874, 212.

UNIVERSAL GAS-LAMP FOR LABORATORIES.

This lamp, as described by Müncke, permits the diminution of the flame to any extent without rendering it liable to strike down, and it can also be made to afford a reducing flame. The flow of gas and admission of the air are both regulated by collars at the end of a horizontal handle, so that the tip of the jet is not liable to injury by liquids, etc., accidentally falling into the lamp; it is, besides, also supplied with a curved attachment for the end of the lamp tube, with which it is impossible for fused substances to run into the lamp. By a flat attachment a broad, narrow flame is afforded, suitable for heating uniformly a considerable length of a glass tube, as in bending it, and by rose and gauze-burner attachments, any desired distribution of the flame can be made; while a tripod, adapted to the support of capsules, flasks, etc., which can be attached to the cast-iron foot of the lamp, and be moved with it, completes its character as a perfect gas-stove.—5 *C*, XXIX., 1874, 231.

DE LA BASTIE'S HARD OR TEMPERED GLASS.

A French engineer, M. François de la Bastie, after a long series of experiments, has discovered a simple means of rendering glass practically unbrittle, and at the same time of preserving its transparency, which it is understood he intends to utilize by commencing the manufacture of articles of toughened glass upon an extensive scale. The process of conversion is, in the main, a very simple one. In general terms, it consists in heating the glass to a certain temperature, and plunging it, while yet hot, in a heated bath of some oleaginous compound. There are, it is represented, many conditions and details upon which the success of the operation depends. Of these, the temperature of the glass and the nature and temperature of the oil-bath are named as the most important. These and other matters of detail, report says, M. De la Bastie has satisfactorily solved, and has constructed furnaces and apparatus with which his tempering process can be carried into effect without risk or failure. The time actually employed in the tempering is but nominal, the articles, heated to the required temperature, being simply inserted into the bath and instantly withdrawn. The cost of the operation is likewise represented to be small.

M. De la Bastie's experiments, it is said, were first made with the object of effecting the toughening of glass by compression, but without success; for although this principle holds good in practice with the metals, and especially with iron and steel, it appears not to apply to glass. By the application of heat in the form of a tempering bath, however, he succeeded in effecting his purpose, and in changing the physical properties of this material to a remarkable degree.

That the invention is attracting considerable notice will be manifest from the following comments of the London *Times* of recent issue: "Of the practical value of M. De la Bastie's discovery there can be no question whatever; nor can there be any doubt of its value in the arts, sciences, and manufactures. The applications which suggest themselves are innumerable; and above and beyond the utility of the process in relation to articles of domestic use, come important considerations affecting the applied sciences, especially in connection with chemical manufactures and similar industries, where a material equally indifferent to the action of heat and acids has been long and vainly sought for—notably in connection with the vitriol chambers in the manufacture of sulphuric acid, and for piping in chemical works."

The technical journals give at considerable length the details of a number of comparative tests of the strength of the Bastie product and of ordinary glass, which appear to be well authenticated. These accounts all agree in the statement that the tempered glass possesses, in comparison with the ordinary glass, an astonishing degree of toughness, whether subjected to the test of rapid alternations of heat and cold or the impact of a falling weight. The following comparative experiment, selected from a number, will serve our purpose. A piece of ordinary plate-glass is reported to have been broken by a 2-ounce brass weight falling from a height of 24 inches. On a thinner piece of toughened glass no impression was made by the same weight falling from heights ranging from 2 feet to 10 feet, the weight simply rebounding from the glass. An 8-ounce weight, tried at 2 feet and 4 feet, gave with the same piece a similar result. At 6 feet, however, the glass broke. The breaking of the plates under these circumstances appears to be attended with the same phenomenon of complete disintegration that characterizes the well-known scientific toy known as Prince Rupert's drop—a coincidence that may be of value in explaining the nature of the change of qualities effected by the Bastie process.

DE LA BASTIE'S EXPERIMENTS IN TEMPERING GLASS.

De la Bastie, the inventor of the process for the tempering of glass, whereby its strength is increased and its brittleness removed, states that all liquids are not suitable for the purpose; that it is necessary by experiment upon each of them to determine those which insure the success of the operation, and among these even a choice will still have to be made. Some in fact double, others quadruple, and others even tenfold increase the solidity of the glass. The maximum strength possible has been determined by Siemens, of Dresden, to be about fifty times that of ordinary glass. Bastie has himself determined for every liquid the co-efficient of its strengthening power. Three elements concur in the determination of this co-efficient: First, the composition of the bath, which is never formed of a single liquid. Secondly, the proportion in which each material enters into its composition; and, finally, its temperature. This last element is not that which has demanded the least amount of study. At one degree of temperature the glass becomes brittle, instead of being tempered. At another temperature it acquires solidity, and at still another it may attain its maximum of solidity. There are also other considerations. The proper temperature of the bath will vary according to the chemical constitution of the glass, and according to the oxides which enter into its fabrication: the different temperatures needed for either of two different glasses may vary to the extent of 200° Centigrade. If one calculates all the combinations which have to be made, in order to determine by purely empirical means the most favorable conditions to success, taking account of the various elements, the composition of the bath, the preparation of the various liquids which compose it, the thermometric state, the chemical constitution of the various glasses, etc., we shall not be astonished that this study has demanded many years of work, which was not always without danger. As to the value of his discovery, from an economical and industrial point of view, De la Bastie states that his researches have not been conducted as an object of mere curiosity. His invention leaves his hand complete in every respect, so that he is ready to manufacture strong and malleable glasses of every kind, for every purpose to which such material can be applied.

It may even replace iron and lead in the construction of gas and water pipes.—*Bulletin Hebdomadaire*, XVI., 22.

EXPLANATION OF SO-CALLED HARDENED GLASS.

No adequate explanation of the hardening of glass by the new method of annealing seems as yet to have been given. Professor Bauer, who has successfully imitated the glass produced by the French method, suggests the following. The glass at once calls to mind the phenomenon of Rupert's drop; but the latter can not be accounted for satisfactorily, since it has been shown that if the point is dissolved off by fluohydric acid, instead of pinched off, the whole drop does not burst. On the other hand, the hardened glass also recalls the fact that, although glass in a state of fusion may be considered as homogeneous, yet upon cooling it does not form a perfectly homogeneous and amorphous mass, as was formerly supposed; but that all varieties, even those that are apparently without a trace of crystallization, are mixtures of crystalline and amorphous particles, as manifested under the action of fluohydric acid. This want of homogeneity in the structure of glass, which is produced to a certain depth by slow cooling, is evidently prevented by rapid cooling. Therefore by cooling fused, or even softened glass very slowly, it may easily happen that this separation into crystalline and amorphous particles may take place. The preparation of so-called Réaumur's porcelain depends on this fact; and quite recent experiments show that the crystalline portions may even become visible, and the glass is said to be devitrified. An explanation of the hardness and peculiar fracture of the hardened glass may be connected with these facts.—14 *C*, CCXV., 1875, 382.

PHOTOSTEREOTYPY.

A sheet of ordinary plate glass larger than the picture to be reproduced is coated in the dark room with a solution made by dissolving 1 ounce of potassium bichromate in 15 ounces of water, warming gradually, then adding 2 ounces of fine gelatin and filtering through linen at the boiling heat. A diapositive is taken from an ordinary negative, and laid with the collodion side to the gelatin face of the prepared plate in diffused light for 10 to 30 minutes. The plate is then taken from the frame in the dark room and washed with water for five or ten minutes, till the relief is fully developed, after which it is dried with filtered paper and coated with glycerine by means of a camel's-hair pencil, and the excess of liquid is removed with filter-paper. From this plate a cast is made in plaster of Paris of the consistency of oil, and from the plaster cast a metal one may be taken.—21 *A*, *Sept.*, 1874, 930.

PHOSPHOR-BRONZE.

M. Delatot, in an article upon "phosphor-bronze," states that it is not an alloy, but a true chemical combination of copper with phosphorus, or a phosphide of copper in definite proportions. The union of the two may be through the cold or the hot process, the cold sufficing for certain applications, being preferable indeed to combinations produced by heat. By the hot process the introduction of simple bodies other than the metals or metalloids is prevented. The copper used in the process must be commercially pure. Of the three kinds of phosphorus the operator may take his choice: the ordinary, the amorphous, and the earthy biphosphates. The amorphous is the most expensive, and is also the best. According to Delatot, the percentage of phosphorus varies from 2 to 4, between which there may be an infinity of degrees, although for industrial purposes five varieties meet all the requirements. These are formed with 2 per cent. of phosphorus, 2½ per cent., 3, 3½, and 4 per cent. Above 4 phosphor-bronze is useless, but between 3 and 4 per cent. the material is claimed to be superior to any other metal or alloy. The price of phosphor-bronze, unworked, should not exceed that of copper plus 10 per cent.—18 *A*, *April* 9, 1875, 97.

N. MATERIA MEDICA, THERAPEUTICS, AND HYGIENE.

THE POISONOUS PROPERTIES OF ALCOHOLS.

Dujardin-Beaumetz and Andigé have made some curious toxicological experiments with the fermentation alcohols of ethyl, propyl, butyl, and amyl. Over sixty dogs were subjected to investigation, and each poison was tested not only through the stomach, but also by administration through the skin. The intensity of the poisoning is greatest when the alcohol is taken into the stomach, and seems, if we arrange the four substances above named in a series, to increase in a serial way. Thus ethyl alcohol (common alcohol), having the lowest molecular weight, is the least poisonous, while amyl alcohol (fusel-oil), at the other end of the list, is the most so.—6 *B*, *July* 26.

A NEW SEDATIVE.

M. Bonneville has investigated the therapeutic properties of monobrominated camphor, and finds it to be a decided sedative. Tested upon small animals, like rabbits and cats, he found it to depress the action of the heart, to diminish the number of respirations without disturbing their rhythm, and to lower the bodily temperature very regularly, in a remarkable degree. Tested upon human beings, it gave satisfactory results in cases of chorea, hysteria, cardiac affections of nervous origin, and epilepsy. The new remedy was dissolved, sometimes in alcohol, sometimes in glycerine, but the dose is not stated.—6 *B*, *August* 9.

DETECTION OF ARSENIC IN TISSUES.

The problem of detecting arsenic in medico-legal cases is often rendered obscure by the liability the chemist incurs of losing a large part of the poison. Gautier now proposes a method by which almost every trace of the arsenic contained in a quantity of muscle, or other animal matter, can be recovered and estimated quantitatively. The finely chopped muscle, liver, or brain, as the case may be, is treated in a large capsule, first with one third its weight of nitric acid, and warmed. When the mass becomes viscous the heat is withdrawn, and a few grammes of strong sulphuric acid added. Then, after warming again until white vapors begin to come off, half the original quantity of nitric acid is poured in, drop by drop. The mass is now to be heated until it begins to carbonize, and a black residue is obtained which can be easily lixiviated by boiling water. To the hot, filtered solution sodium bisulphite is to be added, until sulphurous acid is given off, and then the arsenic may be precipitated in the usual manner by sulphureted hydrogen. In a test experiment 0.005 gramme of white arsenic was mixed with 100 grammes of beef muscle. This should contain 0.00378 gramme of the metal, and 0.00365 was actually recovered.—6 *B*, *August* 2.

DETECTION OF FUSEL-OIL IN ALCOHOL.

According to Bettelli, in order to detect fusel-oil in alcohol it is only necessary to shake the suspected sample, diluted by six or seven times its volume of water, with fifteen to twenty drops of chloroform. The latter takes up any fusel-oil which may be present, leaving it behind after evaporation, to be recognized by its odor. By this method a fraction of one per cent. of fusel-oil is easily detected.—*Bull. Soc. Chimique*, *July* 20, 1875.

GROUNDWORT AS A FEBRIFUGE.

Glocener, of Hainault, announces that he has discovered in the groundwort (*Senecio arvensis*) virtues as a febrifuge superior to those of cinchona and its derivatives. Fifty grammes of the fresh plant, exclusive of the root, are to be boiled for ten minutes in 500 grammes of water, and the solution strained. This is to be taken in three doses, at intervals of two hours, after the attack. In nearly every case positive relief, if not a cure, is claimed as the result.—1 *B*, *January* 10, 1875, 240.

EFFECT OF MORPHIA ON SECRETIONS.

From a paper by Kratschmer upon the influence of morphia, and of carbonate and sulphate of soda on the formation of sugar, and the excretion of urea in diabetes, it appears that in morphia we actually possess a remedy that not only very materially reduces the excretion of sugar in this disease, but decidedly diminishes the metamorphosis of tissue in the body generally. In this respect morphia resembles alcohol and tobacco, and appears to form a valuable means of making up for an imperfect supply of food, provided its secondary influences are not in the way.—13 *A*, *March* 21, 1874, 319.

THERAPEUTICAL USES OF HOT BATHS.

Professor Lasègue, in a paper on the therapeutical uses of hot baths, remarks that these should be of short duration—from twenty to thirty minutes at furthest—the temperature on entering the bath to be lower than that on quitting it, whatever extremes it may reach in the mean time, and the increase of temperature always to be made gradually. The maximum should be 118° Fahr., although 113° is perhaps a better limit. This temperature is easily borne, provided the escaping steam be not felt on the uncovered portions of the body, and also provided that the maximum be not maintained over eight or ten minutes. On leaving the bath the patient is to be placed in his bed, where he soon regains, not his true temperature, which has varied but little, but his apparent temperature. M. Lasègue finds that cold applications immediately after the hot bath, contrary to what takes place after vapor baths, are neither useful nor agreeable. The disease which yields most readily to this system of hot baths, it is stated, is chronic rheumatism producing deformities of the joints, which usually resists all ordinary modes of treatment.—20 *A*, *November* 21, 1874, 588.

INTRODUCING MEDICINES INTO THE SYSTEM BY GALVANISM.

According to Herman Munk, the failures of the various attempts to convey liquid medicaments into the living human body by means of the galvanic current have been because the current has been sent in one direction alone; as he has found that, if a moist, porous body, between liquids of various conductivity, be traversed by the current, the speed of the conveyance of the liquid into this body rapidly diminishes, and soon becomes zero. If, under the same circumstances, the current is reversed, after a short interval, the liquid enters anew from the now positive electrode. By frequently repeating this reversal large quantities of the liquid can be introduced. Mr. Munk has in this way transferred fatal quantities of strychnine solution through the unbroken skin of young dogs, and has introduced chinin and iodide of potassium into his own arm in such quantities as to be readily detected in the excreta. The essential points, therefore, in such operations are that the liquid substance be placed at both electrodes, and that the direction of the current be frequently reversed.—18 *A*, *August* 28, 1874, 614.

DIABETES HEREDITARY.

According to Dr. Schmitz, diabetes, that much-dreaded disease, is almost always the result of congenital predisposition; mental anxiety, severe pain, injuries of various kinds, etc., whether they affect the nervous system or not, being powerless to bring about the affection without an inherited tendency to it.—20 *A*, *December* 5, 1874, 635.

ACTION OF JABORANDI.

Mr. Martindale, of University College Hospital, England, gives an account of an experiment upon himself of the physiological action of the new Brazilian drug, jaborandi, which has been highly commended as a sudorific and sialagogue. An infusion of sixty grains of the bruised leaf, in five ounces of water, was prepared, and the equivalent of about fifty grains swallowed by Mr. Martindale. In a very short time he felt an increased circulation and an uneasiness in the head, with a rapid secretion of saliva. In a quarter of an hour he perspired freely, and the perspiration and salivation rapidly increased to such a degree as to blur his eyesight. The pulse rapidly rose from 96° to 104°; the perspiration poured out from all parts of the body, the saliva for a time required almost constant ejection, and the speech was affected so that articulation was difficult and indistinct. After a time vomiting came on, which threw off a portion of the solution of the jaborandi. There were many uncomfortable symptoms attendant upon the experiment, which, however, passed off after a time. The saliva collected during the experiment weighed nearly sixteen ounces, in addition to a quantity which flowed on the pillow while the patient slept.

The sweating was so excessive that the clothing was saturated, and even the bedding wetted, the perspiration passing off almost in the form of vapor.

The question of the precise botanical character of jaborandi has been a matter of considerable discussion, but according to a recent article in *The Pharmaceutical Journal*, by Mr. Holmes, there are two or more distinct varieties of the drug, one of which is very nearly, if not entirely, identical with *Pilocarpus pennatiflora;* another is from a genus not yet known; and still another from a species of *Piper*.—20 *A*, *January* 23, 1875, 92.

INTRAVENOUS USE OF CHLORAL FOR ANÆSTHESIA.

Oré, in an article upon the employment of an intravenous introduction of chloral in anæsthesia, remarks that an essential condition consists in the puncture of the vein without laying it bare. For use, one part of chloral is dissolved in three of water; sometimes, however, one part to five. Five grammes of the chloral itself in this mixture are necessary to produce satisfactory anæsthesia, and even more in some cases. Where the dose necessary for anæsthesia is from five to eight grammes, these should be introduced at the rate of about one gramme per minute, so as to allow its thorough circulation throughout the system. The advantages of this method of anæsthesia are that the respiration is never disturbed, and perfect insensibility can be secured for a period of time varying with the dose; no undue excitability is produced, and there is never any vomiting, while the operation is always followed by calm, regular slumber, which may be made to last twelve, eighteen, or even twenty-four hours, so as frequently to do away completely with the common effects of severe operations. Finally, there are never any symptoms of phlebitis, or hæmaturia, when the operation is properly performed.—6 *B*, *November* 2, 1874, 1014.

NEW PROCESS IN DENTAL SURGERY.

Mr. Napier announces what he considers to be something new in dental surgery, especially in a case where the teeth were extremely sensitive, and it became necessary to file them down for the purpose of introducing artificial teeth on the stumps. For the sake of avoiding pain in the operation, as far as possible, ether spray was first made use of in reducing the sensibility of the teeth; a piece of cotton, dipped in ether, and laid first on the teeth and then on the instrument, being found to answer a still better purpose. While engaged in this operation, it occurred to Mr. Napier to avoid the usual practice of dentists (viz., of extirpating the nerve), with which object he took a bit of hard wood, dipped it in nitric acid, and with this cauterized the exposed portion of the nerve in each tooth successively. He then filed the teeth down to the level of the gums without producing any pain whatever. He found that in this way the stump of the tooth remained perfectly healthy, giving no pain of any kind; and the subsequent experiences of the patients were of the most satisfactory character.—20 *A*, *December* 5, 1874, 629.

CAUSE OF DISCOMFORT IN TOBACCO-SMOKING.

Quite recently Dr. Krause announced, to the dismay of smokers, that a large amount of carbonic-oxide gas is generated in the process of smoking, and that the uncomfortable feelings experienced by beginners are due to the swallowing of a portion of this. Dr. Vohl, however, disagrees with this conclusion, and thinks that the effects in question must be ascribed to the volatile organic bases which form while tobacco is burning.—12 *A*, *May* 6, 1875, 15.

PERNICIOUS ANÆMIA, A RECENTLY DEFINED DISEASE.

The Medical Times and Gazette calls attention to the existence of a disease called pernicious anæmia, not previously distinguished from the great mass of afflictions which man is heir to; referring at the same time to the gradual progress in the accurate identification and definition of diseases, and to the fact that it is but lately that such well-known affections as Bright's disease and Addison's disease have been clearly appreciated. Pernicious anæmia, it seems, very often follows chronic diarrhœa, and child-bearing appears to especially predispose to it. Those affected become extremely pale, the skin of the hands, feet, and face acquiring a swollen look. They become weak, and have attacks of giddiness and palpitation of the heart, with failing appetite, and a feeling of oppression in the epigastrium. Transient diarrhœa sometimes occurs, and feverishness without any attack of fever.

Anæmic murmurs are occasionally present with such intensity as to suggest organic disease of the heart, although none is ever found after death. With all this, the remarkable fact exists that there is very little diminution of the fat covering the body. Sometimes there are hemorrhages from the nose and kidneys, accompanied by pernicious paralyses toward the end of life, when also dropsy sometimes sets in with delirium. The course of the disease is always chronic, and the determination always fatal; and after death a fatty degeneration of certain muscles of the heart, and of some of the small blood-vessels, is noticed.—20 *A*, *November* 21, 1874, 582.

DE CHÉGAIN ON HEADACHES.

De Chégain, in a paper upon ordinary headaches, takes the ground that they result from a nervous affection of the arteries, that their starting-point is in the grand sympathetic nerve, and their precise seat is in the nervous filaments which accompany the arteries; their material phenomena consisting in the dilatation of these vessels, and the compression which they produce upon the brain and other organs, since in a genuine attack of intense headache the patient suffers everywhere: the hands are swollen, the muscles are sore, and every movement is painful. From his studies on the subject, M. De Chégain concludes that any treatment for headache should be directed against affections of the nervous system, especially of the great sympathetic, and against the arterial dilatation which results, and constitutes the essential feature of the malady, and that in this there are three points to be considered: the intermittence, the pain, and the arterial dilatation. His special treatment, founded upon the consideration of these circumstances, consists in the administration of pills composed of:

Sulphate of quinine...................	0.05	of a gramme.
Tannin..............................	0.05	" "
Aconitine...........................	0.001	" "

He prescribes one of these pills a day, although he states that, by a continuation of this treatment, those who have become accustomed to it may use three or four pills per day with marked success. The tannin appears to have a special action, illustrated by the relief experienced from the continued use of certain substances, such as Paullinia (guarana) in large quantity. Such a treatment, however, according to the author, is incomplete, as it has no reference either to the intermittence or to the pain, which are to be antagonized by the other substances recommended.—12 *B*, *Jan.* 30, 1875, 92.

CURABILITY OF PULMONARY DISEASE.

Pietra Santa, in a communication to the Academy of Sciences of Paris, takes occasion to contest the doctrine of the incurability of pulmonary disease, which in his opinion is an affection essentially general and constitutional, an alteration of the function of nutrition, and a disease of the blood. While there is no panacea for this affection, he thinks that many cases may be greatly alleviated, and, indeed, entirely cured, by following a rational treatment. This consists in the intelligent and reasonable use of sundry medicaments, of which experiment and clinical observation have shown the efficiency, and which may be summed up in the following precepts:

First, in all periods of the disease the assistance is to be invoked of suitable hygienic and moral treatment, a pure atmosphere, a tonic diet, moderate exercise, and the use of milk for food. Second, the administration of certain mineral waters. Third, a salutary change of place and of migration, always into southern temperate regions during winter, and to mountainous countries in the summer. Fourth, the use of hyposulphites and the alkaline sulphites for the treatment of the tuberculous matter developed in the lungs. Fifth, calling into play numerous agencies of general therapeutics, when they can be employed to meet the various complications connected with each period of the disease.—6 *B*, *November* 2, 1874, 979.

RELATION OF BACTERIA TO PUTREFACTIVE DISEASE.

Dr. Klein, of the Brown Institution, in London, has published a paper in reference to the relation of bacteria to putrefactive diseases, and has found, in the course of certain investigations upon the small-pox of the sheep, that the lymphatic vessels of the loose tissue beneath the skin, and elsewhere, are occupied by the branching filaments of a fungus-like organism. In the pustules which form on the surface these filaments give rise to minute rounded spores, which have also been seen by other observers, and recognized as special "corpuscules" of the diseases small-pox and vaccinia. In investigating the phenomena of typhoid fever, he has ascertained that in the ulcerated intestines there are immense numbers of minute, round, yellowish-green organisms, both in the tissues of the intestinal wall and in the villi of the surface.—15 *A*, *Oct.* 31, 1874, 580.

DANGER OF EATING FISH IMPROPERLY CURED, OR CAUGHT IMMEDIATELY AFTER THE SPAWNING SEASON.

The importance of the exercise of suitable care in regard to public fisheries may be appreciated from the fact, now quite well established, that the consumption of fish improperly cured, or taken during the exhaustion following the spawning season, produces serious evils, these, among others, consisting in part of a modified form of leprosy and elephantiasis—diseases directly traceable to the cause referred to both in Norway and in India.—12 *A*, *Dec.* 31, 1874, 175.

SELECTION OF THE WATER SUPPLY OF CITIES.

A valuable report by Professor Chandler upon the sanitary chemistry of waters, and suggestions with regard to the selection of the water supply of towns and cities, has just been reprinted from papers of the American Public Health Association, the whole forming an important manual in connection with the plans of water supply for towns and cities.

Professor Chandler in this report considers the nature of the impurities contained in water and their effect upon the public health, and devotes particular attention to the pollution of streams by the refuse from factories and by sewage. He is, however, quite satisfied that a certain class of impurities, especially those of an animal nature, in time become harmless by their decay, consequent upon their combination with the oxygen in running waters; this relief, however, not applying to the case of confined wells. The experiences of the Thames coincide with those of the Hudson in this respect.

It has been calculated that sewage mixed with twenty times its volume of running water, after flowing a distance of ten or twelve miles, is absolutely purified by infusorial animals, aquatic plants, and chemical oxidation.

The Professor makes a special application of his researches to the Croton water, and states as a general conclusion from the whole that for the supply of cities rivers and lakes are very decidedly superior to wells, which should always be viewed with suspicion, on account of the danger of contamination from the drainage of the soil, and leakages from the cess-pools and private vaults.

PICRIC ACID AS A TEST FOR ALBUMEN IN URINE.

Picric acid is recommended by Dr. Galippe as the best reagent for the detection of albumen in urine. The urine should be added drop by drop to a few cubic centimeters of a solution of the acid in water, when any albumen present will produce a characteristic cloudiness, not to be confounded with any thing else. If the picric acid is added to the urine no reaction will occur.—15 *C*, VII, 1875, 111.

SALICYLIC ACID.

Salicylic acid still continues to find favor as an antiseptic, supplanting in this respect carbolic acid and other predecessors. How long it will maintain its present position is, of course, a matter of uncertainty. This acid is slightly yellow in color, taking the form of fine crystals, which are readily soluble in alcohol and ether, as also in hot but not in cold water. It melts at 318° Fahr. When heated rapidly it is resolved into carbonic and carbolic acids. In addition to its alleged superior efficiency, it is much preferable to carbolic acid in lacking any smell and any unpleasant taste.

According to Professor Neugebauer, a small quantity of this acid is sufficient not only to prevent the second or after fermentation of wine and its consequent muddiness, but also the formation of fungi in the casks.

According to Professor Kolbe, half a gramme of the acid will check the fermentation produced by five grammes of yeast in a solution of sugar. It is said to prevent the decomposition of water on shipboard when added in the proportion of 1 to 200,000. By covering the bung-hole of the casks with cotton steeped in the acid, the filtration of the air will affect the preservation of the water within the cask.

The process of curdling in milk is retarded for thirty-six hours by the addition of 6.04 per cent. of the acid. It is peculiarly adapted for use as a dentifrice, and as a preventative of the disagreeable odor from perspiration.

For the still more important purpose of surgical dressing it arrests the smell of putrefaction without producing inflammation; and a solution of it promotes the growth of the skin over granulating surfaces. Its use internally has been suggested for those diseases which are contracted from contagion.—17 *A*, *June* 1, 84.

COMPARATIVE ANTISEPTIC EFFECTS OF CARBOLIC AND SALICYLIC ACIDS.

In repeating the experiments of Kolbe upon the antiseptic effects of salicylic acid, Müller, of Breslau, found that while $\frac{1}{1000}$ part of carbolic acid would prevent the fermentation of a ten per cent. solution of grape-sugar, as well as the same amount of salicylic acid, the latter is more effective when the solution of sugar is more dilute. Again, while 0.04 per cent. of salicylic acid retarded the souring of milk for thirty-six hours, the same percentage of carbolic acid was absolutely without effect. Still the action of salicylic acid depends somewhat upon the temperature, as Kolbe admits; and his experiments were conducted with milk at 64°, instead of full summer-heat. With urine, however, salicylic acid proved far less effective in restraining putrefaction than carbolic acid; but, on the other hand, while 0.2 per cent. of the former entirely prevented the decomposition of amygdaline after the addition of emulsine, ten per cent. of carbolic acid was required to produce the same effect. A still greater difference was found in their restraining action upon ptyaline, liver-ferment, and pepsin. The decided effect upon the action of the latter does not harmonize with its effect within the organism, as Kolbe took from fifteen to twenty-two grains per day, for several days, without experiencing any injurious effects, and Müller repeatedly took from four to eight grains without its producing disturbance of digestion. The rapid excretion of the salicylic acid is suggested by the latter in explanation of this apparent contradiction, as it was detected in the urine two hours after it had been taken, and none could be detected after twelve hours. He also regards the superior restraining effect of salicylic acid upon fermentation and putrefaction as due to the added effect of its acid properties, which carbolic acid does not possess.

JABORANDI, A NEW BRAZILIAN REMEDY.

A medicinal product from the *Pilocarpus primatus* of Brazil, known as *jaborandi*, is claimed by Dr. Coutinho, of Pernambuco, to be a very valuable remedy in many diseases, especially as a diaphoretic and sialagogue. An infusion of four to six grammes of the leaves, in a cup of cold water, produces in a short time an excessive perspiration and salivation. The saliva flows in so great abundance that as much as a liter has been collected in less than two hours. The bronchial secretion is also increased. The after-effects of this remedy are claimed to be perfectly inoffensive. The promptness of its special action is of great importance in many diseases, and it is thought that an important future is in store for this new substance.—12 *B*, *March* 30, 1874, 282.

ACTION OF AIR ON THE LUNGS IN CERTAIN CASES.

According to Dr. Bert, exposure to the air of certain pyritiferous subterranean recesses, such as caves or mines, produces all the symptoms of mountain-climbing, including syncope, the result being, as supposed, in the diminution of the amount of oxygen, caused by the iron pyrites, which passes gradually to the condition of a sulphate.—13 *B*, *April* 18, 1874, 203.

HYDRATE OF CHLORAL IN INFANTILE CONVULSIONS.

According to Derim, the hydrate of chloral is almost a specific against the occurrence of convulsions in children, especially where these result from some trifling cause, such as difficult dentition, intense emotion of any kind, etc.; and even in a case where there is some severe local cause it is said to prevent convulsions, and allow the administration of proper remedies. The preparation of Dr. Derim contains one gramme, or fifteen grains, of the chloral, this being given every half hour, or even every quarter of an hour in urgent cases, until the convulsions cease and quiet respiration succeeds.—11 *B*, *April* 1, 1874, 174.

O. MISCELLANEOUS.

REPORT OF THE AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK, FOR 1874.

The report of the American Museum of Natural History for 1874 has just been published by the directors. The rapid progress that has been made in the enterprise is best shown by the announcement that the corner-stone of the new fire-proof building was laid during the year, and that it will probably be completed in the course of the year 1875.

The more important additions to the collections of the museum during the year have been the conchological cabinet of Dr. John C. Jay, embracing 50,000 specimens, and a valuable library of conchological works of about 1000 volumes. Mr. R. A. Witthouse has presented 2000 species of American coleoptera. A series of sixteen skeletons of the gigantic moas, or fossil birds of New Zealand, has been received in New York. The department of anthropology has been enlarged by the purchase of the collections of Indian antiquities made by Dr. E. H. Davis and by E. G. Squier, and that of mineralogy by the purchase of a collection of minerals, embracing 7000 cabinet specimens.

During 1874 $13,000 were subscribed for the purchase of new and attractive collections, which sum was invested in procuring the series just mentioned. There is at present no definite endowment to meet the expenses of the museum, the institution being dependent for this upon the contributions of its annual members, who pay $10 each. Subscriptions of $100 and upward are reserved for increasing the collections. The membership has been augmented during the year from 350 to 1100, and it is hoped it will soon be sufficiently large to furnish all the means necessary to secure the best scientific assistance in the various branches of the museum.

KIRTLAND SCHOOL OF NATURAL SCIENCES.

The Kirtland School of Natural Sciences, established in Cleveland, Ohio, concluded its course on the 9th of August.

The school consisted of twenty members, of whom thirteen were ladies, and lasted for five weeks, during which time gratuitous instruction was given by lectures and otherwise, and short excursions were made in connection with the subjects of study. Dr. Newberry, Professor Theodore B. Comstock, Professor Albert Tuttle, and Dr. William K. Brooks were the instructors.

The operations of the school were mainly conducted by Professor Comstock. Facilities were extended by railroad and steamboat companies in the transportation of the school and in various interesting excursions.

NORMAL SCHOOL OF NATURAL SCIENCES.

Among the other natural-history schools conducted during the past summer, somewhat on the plan of that at Penikese, was one at the town of Normal, in Illinois, which closed on the 11th of August, after a four weeks' course. The class was divided into sections, each section working in concert on the same subject, under the guidance of an instructor. Thirty lectures were delivered, one or two each day, having close relation to the laboratory work.

The instructors consisted of Professor Burt G. Wilder, Professor W. S. Barnard, Professor T. G. Burrall, Professor Cyrus Thomas, and Professor S. A. Forbes.

The materials for the zoological course were abundant, being derived partly from Lake Michigan and the Illinois River, and partly from the New England coast, gathered principally by Professor Van Vleck, at Wood's Hole, the head-quarters of the United States Fish Commission. It was stated that a greater variety of animals was available for study than at Penikese itself. Among others was a supply of the lancelet, or amphioxus, the most rudimentary of known vertebrates, received by Professor Wilder from Naples.

FIRST ANNUAL REPORT OF THE ZOOLOGICAL SOCIETY OF CINCINNATI.

The first annual report of the Zoological Society of Cincinnati for the year 1874 has been published, giving an account of the present condition of that important enterprise. From this we learn that, after various efforts to secure a proper site, a suitable locality was obtained in the southwestern corner of Avondale, of 66 acres, for which a reasonable annual rental is to be paid. About $120,600 have been raised in the form of capital stock, and this, with the regular receipts, will be quite sufficient for carrying on the establishment and furnishing handsome interest on the investment. The gardens of the Society, containing fifty-six acres, were opened to the public on September 18th.

FIRST ANNUAL REPORT OF THE GEOLOGICAL AND AGRICULTURAL SURVEY OF TEXAS.

Dr. S. B. Buckley has published his first annual report of the Geological and Agricultural Survey of Texas, in which he gives an account of the labors of his predecessors and of his own operations during the year. In addition to a general sketch of the economical geology of the country, we have tables of precipitation and temperature, an indication of the principal soils and animal and vegetable products, etc., with a reproduction of a defense made some years ago by the author against criticisms by Professor Gray in regard to certain species of Texas plants described by him as new.

ANNUAL REPORT OF THE UNITED STATES GEOLOGICAL AND GEOGRAPHICAL SURVEY OF THE TERRITORIES FOR 1873.

One of the most important of the many valuable government documents is the Annual Report of the United States Geological and Geographical Survey of the Territories for 1873, as prepared by Dr. Hayden, being a volume of 730 pages, profusely illustrated with plates and sections, and exhibiting the physical geography, the sectional geology, the mining, and the natural history of the country.

The volume consists of several sections. The first—that of geology, mineralogy, and mining industry—was prepared by Dr. Hayden, Mr. Marvine, Mr. Peale, and Dr. Endlich. The second embraces special reports on paleontology, on the fossil flora by Professor Lesquereux, and on the vertebrates by Mr. Cope. Part third—zoology—contains articles on the recent invertebrates, by Lieutenant Carpenter, Dr. Packard, Baron Ostensacken, Mr. Ulke, Dr. Hagen, Mr. S. J. Smith, Professor Verrill, and Mr. William G. Binney. Part fourth—

upon the geography and topography—is from the pen of Mr. James T. Gardner, geographer of the expedition. There is also an appendix, by Mr. A. R. Marvine.

The book is, of course, indispensable to all persons interested in the physical geography and natural history of the West.

ARRANGEMENTS FOR A BOTANICAL GARDEN IN CHICAGO.

A commendable enterprise has been initiated in Chicago, by the South Park Commissioners, in the setting apart of sixty acres for the establishment of botanical gardens, this space to be increased from time to time as occasion may require. The general management of affairs is in charge of the board, of which Mr. N. H. Hibbard is president and H. H. Babcock secretary.

It is proposed to have a botanic garden proper, provided with suitable houses for the reception of plants requiring protection, an arboretum, a garden for general floriculture, a botanical museum, an herbarium, and a botanic library. A circular has been issued by the board of managers, soliciting contributions to the several departments of the garden, especially of seeds, cuttings, living plants, and herbarium specimens. This solicitation is made with the expectation of being able to make proper return for such contributions at an early day. The general direction of the establishment has been placed in charge of Mr. H. H. Babcock.

THE CHESS PROBLEM OF THE EIGHT QUEENS.

The chess problem proposed by Nauck to the distinguished mathematician Gauss, viz., to determine the number of ways in which eight queens can be placed on a chess-board so that no one can take or be taken by any other, has been completely solved by Gunther, whose solution has been somewhat improved by Mr. J. H. L. Glaisher. According to these gentlemen, for a chess-board of sixteen squares and four queens there are two solutions of the problem, in a board of twenty-five squares, ten solutions, and in a board of sixty-four squares, with eight queens, ninety-two solutions. Of these ninety-two solutions, one is perfectly symmetrical, and is given by Mr. Glaisher in full.—7 *A*, XLVIII., 456.

REPORT ON THE POPULATION OF THE EARTH.

The number of Petermann's *Mittheilungen* for March, 1875, contains the usual annual report upon the population of the earth, made by Messrs. Behm and Wagner. The footing for the year 1874 is as follows:

Europe	302,973,000
Asia	798,907,000
Africa	206,007,000
America	84,392,000
Australia and Polynesia	4,563,000
Total	1,396,842,000

—17 *C*, *March*, 1875.

JAPANESE GAME OF CHESS.

In a recent number of the proceedings of the German Society at Yokohama, an interesting account is given by Holtz of the Japanese game of chess. The chess-board is, he says, divided into eighty-one squares of the same light yellow color, which are distinguished among themselves by drawing black lines over the yellow board. The squares are not true squares, but somewhat longer than broad, in order to correspond to the figures of the chess-men themselves. The figures are, like the board, of the same color, but of a more decided yellow, perfectly distinguishable from that of the board itself. In the English game we have thirty-two pieces and sixty-four squares. In the Japanese we have forty pieces and eighty-one squares. The separate figures are of different sizes, in proportion to their value, but have all the same shape, *i. e.*, very nearly that of a truncated pyramid. The queen is the greatest, the peasants the smallest; but the difference in size between the separate figures would scarcely suffice to prevent mistakes, if it were not that the name and value of each figure are written in Chinese letters upon their upper sides. Except the queen and certain other figures, they all have also a second sign on their bases, which bases are turned uppermost during the first part of the game, and only turned down when the piece itself has reached the enemy's side of the board. The pieces are so placed upon their squares that the narrower sides are turned toward the opponent, so that one at a glance easily recognizes each of the figures belonging to the other party. In this way the Japanese, by the position of their figures, attain the same end that the Europeans accomplish by differences of color. Concerning the movements of the pieces, which Holtz describes in detail, we will only state that the king's moves are very similar to those in the European game. There is no piece whose movements correspond to those of the queen in the English game.—*Mitth. Deutsch. Gesell., Yokohama, July*, 1874, 13.

REPORT OF THE ICELANDIC COMMISSION TO ALASKA.

During the summer of 1874 a committee of the Icelanders resident in Wisconsin visited Alaska for the purpose of ascertaining whether that country would be suitable for an emigration of Icelanders from their native island. The Secretary of the Navy furnished them transportation on board the *Portsmouth*, and secured to them ample opportunity of making the examination in question. Their report has just been printed by the government, from which we learn that the investigation was highly satisfactory to the committee, and tended to dispel many of the prevalent ideas as to the character and value of the region.

On Cook's Inlet the committee found large varieties of fine timber and an unexpected amount of summer weather, the winter beginning as late as the middle of November and ending the middle of March. They were informed by a resident that cabbages, potatoes, and other garden vegetables grew readily, and that nothing else, to his knowledge, had ever been tried. He stated, however, that there was a settlement near by where rye was raised. They were very decided in their impression of the advantages which the island of Kodiak would furnish to the people of their country, there being an abundance of timber east of the 151st meridian; west of that it was open plain, with plenty of excellent pasturage. Potatoes they found to do well, as also cabbages, turnips, and other vegetables. They considered that any thing which grows in Scotland would succeed in Kodiak. Pasture land they found admirable all along the coast, and considered it probable that it was equally good in the many valleys which lead from the bays to the interior. Fish were very abundant, salmon being in the greatest profusion, while codfish and halibut were also very plenty, and were caught without boats, fishing from the wharf or rocks. They corroborate very emphatically the general accuracy of Mr. Dall's report of the country as contained in "Alaska and its Resources," and consider him correct in all essential matters. The land in every respect has advantages over Iceland, the climate being milder in winter without being warmer in summer, and the summer lasting longer than it does in Iceland. "They therefore do not hesitate to recommend those of their countrymen who are minded to emigrate to do so, and they make this recommendation after conscientious deliberation, and in the firm belief that it would be for their advantage, the land appearing in every respect adapted to their needs, and answering completely all their expectations."

BEQUEST TO THE CINCINNATI SOCIETY OF NATURAL HISTORY.

The Cincinnati Society of Natural History has lately received a bequest of $50,000 from Mr. Charles Bodman, of that city. The gift is absolute and without conditions. Mr. Bodman was a member of that society, and has thus endeavored to place it on a permanent basis, and enable it to become one of the prominent institutions of Cincinnati.

SCIENTIFIC BALLOONISTS.

The investigation of the atmosphere by means of observations in balloons has, during the past few years, been prosecuted with marked activity by the French aeronauts, who have organized the French Society for Aerial Navigation. This society, having clearly seen that ascensions, to be of value, must either aim at attaining great heights or at remaining a long time in the atmosphere at moderate heights, undertook during the present year one voyage of each description, the first of which was that of the 23d of March, the object being to secure a long duration. The ascent was made from the gas-works at Villette, near Paris, at 6.20 in the evening; the descent was made on the following day at 5 o'clock, the entire voyage having lasted twenty-two hours and forty minutes. Among the apparatus taken with them, besides those pieces that are the invariable accompaniments of such expeditions, there was a Davy's lamp for illumination at night, two beautiful spectroscopes, and an instrument by the aid of which it was easy to determine the velocity of the wind—that is to say, the velocity of the horizontal movement of the balloon. Tissandier also experimented with the aspirator to determine the quantity of carbonic-acid gas. Sivel introduced, apparently for the first time in French aeronautics, the guide-rope, with which American readers are familiar from its usefulness in the expert hands of Mr. S. A. King, of Boston. The rope used by Sivel was, however, some 4000 feet long, and it was intended that it should generally touch the earth and glide along over the soil, thus acting as a rudder to the vessel, giving a certain fixed direction to the car of the balloon, and preventing its gyration. Sounding balloons, as they were called, were also devised by Sivel. One of them was filled with illuminating gas, the other with air, and these two balloons, fixed at the end of a horizontal rod, floated one above and one below the car, and always indicated the relative upper and lower winds. During the night the altitude of the balloon oscillated between 700 and 1100 meters, the temperature being between 1° and 4½° C. Cirri were always above the balloon, increasing during the night, and giving rise to a magnificent halo in the morning on the rising of the sun. The moon was also surrounded by a similar halo. A moderate southwest wind had been predicted from the consideration of the weather charts, and was actually experienced, replacing the northeast wind with which they started. The balloon followed the prominences of the soil very exactly, being pushed up over the hills by the ascending current whenever it came to any elevation. This fact was especially manifest in that portion of the voyage during which the altitude was but 600 meters. The balloon itself was frequently inclined out of the vertical. Very appreciable variations in the velocity of the wind were experienced, amounting to between five meters per second during the night and ten meters at sunrise, and diminishing in the upper regions, contrary to the usual experience. Slight traces of electricity were observed at sunrise, but not during the night.—*Bull. Hebd.*, XVI., 33.

INDEX OF PATENTS FROM 1790 TO 1873.

A very important work has just been commenced by the Patent-office, under the title of "Index of Patents for Inventions issued by the United States Patent-office from 1790 to 1873, inclusive. Compiled and published under the direction of M. D. Leggett, Commissioner of Patents." The first volume, a royal octavo of 649 pages, was published in 1874, and the remaining volumes will follow in rapid succession.

The method adopted is strictly alphabetical, the subjects being given in their alphabetical sequence, with name of inventor, his residence, and the date and number of the patent. Should full details in regard to any invention be desired, they can be obtained, of course, by reference to the original patent.

DECIPHERING CHARRED MANUSCRIPT.

A large number of valuable papers that had been charred, apparently to a homogeneous mass, during the Communist rule in Paris, have been deciphered by Rathelot. He first severed the leaves by cutting the backs of the books and immersing the mass in water, then subjected it to a tolerably high temperature at a hot-air stove. The leaves, thus loosened from each other by the rapid vaporization of the water, were with great care separated, and were immediately transcribed, the writing being quite legible, as the letters appeared dull upon the glistening black surface of the paper.—8 *C, Sept.* 24, 1874, 347.

ASTRONOMY IN BRAZIL.

The Imperial Astronomical Observatory of Brazil is a dependence of the Central College of Rio Janeiro, and is destined not only to teach practical astronomy to the students, but to make and publish astronomical and meteorological observations. The chronometers of the navy and army are there regulated, and the time is given daily by signal to the city. The building is situated on an eminence within the city, and the government is now taking measures to improve its scientific character. The director is at present in Europe, with a view of procuring such instruments and apparatus as may be adapted to the studies required of the institution.

An entire reorganization of the observatory is under way, with the purpose of training more thoroughly the persons charged with geologic and geodetic works. There is also an observatory at the capital of the province of Pernambuco.—"*The Empire of Brazil*," p. 293.

ASTRONOMY IN CHINA.

The astronomical instruments sent by the Academy of Paris to China are to remain at Pekin, and possibly a permanent observatory may be established there. The French astronomers who are at Pekin report that the instruments set up by the Jesuit missionaries in the last century are still in perfect order. We believe that the American astronomers were instructed to inquire whether the original observations made by these missionaries were still in existence, and whether they would possibly, in some respects, be worthy of the attention of astronomers of the present day.

SUMS VOTED BY THE BRITISH PARLIAMENT FOR SCIENTIFIC INSTRUCTION.

It will probably be many years before the United States, as a nation, follows the example of Great Britain to any considerable degree in making grants for the purposes of scientific education and instruction. The following table will show the amount voted by Parliament in 1874 for a few of these establishments:

British Museum	£102,442
Kew Gardens and Museum	17,862
Geological Museum	8,998
Edinburgh Museum of Science and Art	9,824
Dublin Museum of Natural History	1,672
Dublin National Gallery	2,380
Museum of the Royal Irish Academy	2,084
Total	£145,262

—15 *A*, *Feb.* 13, 1875.

METEOROLOGY IN CHINA.

The Jesuit college of Zi-ka-wei, near Shanghai, China, has lately begun the publication of the meteorological observations taken by the fathers at the college. These have been made three times a day since 1868, and are printed upon monthly sheets, the first of which contains the observations for December, 1872. Notwithstanding the southern latitude of Shanghai, it is noted that there were forty-nine days of freezing temperature during the four months from 1872 to March, 1873, the minimum temperature being 16° Fahr. on the 31st of January. Shanghai is 5½° farther south than New Orleans. The instruments used at Zi-ka-wei are approved modern standards, similar to those adopted in France by St. Clair Deville.—*Nouvelles Météorologiques, Société de France.*

FOURTH MEETING OF THE FRENCH ASSOCIATION.

The fourth annual meeting of the French Association for the Advancement of Science took place at Nantes in the end of August, closing on the 26th. The session was a satisfactory one, and very largely attended, and many important papers brought forward. The meeting for 1876 is to be held at Clermont Ferrand, and that for 1877 at Havre.

ANNUAL REPORT OF THE COUNCIL OF THE ZOOLOGICAL SOCIETY OF LONDON.

The annual report of the Council of the Zoological Society of London, made April 29, contains the usual record of prosperity of this world-renowned establishment. The total enumeration of members of different grades at the close of the year 1874 is given at 13,197, a considerable number having been added during the year. The only foreign member elected was Mr. Alexander Agassiz, to fill the vacancy caused by the death of his father. Of corresponding members the only American elected was Dr. H. C. Yarrow, of Lieutenant Wheeler's survey.

The income of the society for 1874 was the largest since its foundation, amounting to about $142,000, of which the receipts from the Zoological Garden were about $84,000. This is a diminution compared with the receipts of the previous year, due largely to the unfavorable weather of certain special holidays.

The total number of visitors to the gardens during the year amounted to about 707,000, exceeded previously only by the numbers in 1873.

The Council announced that a series of lectures was to be delivered during 1875, upon popular subjects connected with the living animals of the menagerie, principally by Dr. Sclater, Mr. J. W. Clarke, Professor Garrod, Professor Flower, and Professor Mivart.

Among the additions to the menagerie during the year, the most important is that of a rhinoceros from Java, making the fourth species of the genus now living in the gardens. The whole number of additions of all kinds amounted to 1202, of which 425 were donations.

INTERNATIONAL CONGRESS OF SILK-CULTURISTS.

An International Congress of Silk-culture is to be held at Milan during 1876, and circulars have been distributed inviting a series of experiments to be made during 1875, and a report on the results. This has reference to various points connected with the keeping of silk-worms, the prevention of injurious diseases, particularly of their "inactivity," a disease which has produced great injury of late years.—12 *A*, *April* 6, 1875, 456.

REPORT OF ROYAL COMMISSION OF SCIENTIFIC INSTRUCTIONS.

The final report of the Royal Commission on scientific instruction and the advancement of science, which has been engaged for a number of years past in investigating the question of high scientific education and the relations of science to the state, has just been published, being the eighth of the series. The conclusions to which it has attained are, in brief, as follows:

First. It finds that the assistance given by the state in Great Britain for the promotion of scientific research is inadequate, and that the concession or refusal of assistance does not take place on any definite principle.

Second. That more complete means are urgently required for scientific investigations in connection with certain government departments, and that physical as well as other laboratories and apparatus should be provided.

Third. Certain classes of phenomena, such as those relating to physical meteorology and terrestrial and astronomical physics, require observations of such a character that they can not be advantageously carried on otherwise than under the direction of the government. Institutions for the study of such phenomena should, therefore, be maintained by the government especially, and an observatory established devoted to astronomical physics, and an organization for the more complete observation of tidal phenomena, and for the reduction of observations.

Fourth. Aid should be extended to persons engaged in important physical and chemical investigations, as is now done to those connected with the government collections of natural history.

Fifth. While grants of money, merely covering actual outlays of expenses in certain investigations, have been made, it is quite proper that something more than this should be done under certain circumstances, especially where a competent individual engaged in some important research is unable to meet his own personal expenses.

Sixth. The grant of £1000 administered by the Royal Society has been of so much benefit as to warrant a considerable increase.

Seventh. A ministry of science and education should be created for the proper disposition of the funds for research, and the general supervision of scientific work as connected with the state or controlled by it.

Eighth. The services of such a ministry of science and education would be greatly furthered by being associated with a scientific council of the Royal Society, representatives of other important societies, and a number of persons nominated by the government.

These conclusions are unanimously indorsed by all the members of the commission, consisting of the Earl of Devonshire, Lord Lansdowne, Sir John Lubbock, and Messrs. P. Kay-Shuttleworth, Bernard Samuelson, W. Sharpey, Thomas H. Huxley, C. G. Stokes, and Henry J. S. Smith.

BELGIAN EXHIBITION OF 1876.

Belgium announces for the coming year an exhibition of quite novel and eminently praiseworthy character, namely, an exhibit of apparatus designed in any manner to save life or health. The project has been undertaken at the suggestion of the Société Royale des Sauveteurs de Belgique, whose labors and publications in the cause of humanity are warmly acknowledged. A feature of the exhibition will be the experimental trial of apparatus as far as this is practicable. Experiments on the river or the sea will take place at Antwerp or Ostend, and the factory owners have signified their desire to co-operate in aiding the conduct of such trials as can only be made in workshops and factories.

The following is a summary of the several heads or classes under which exhibition is desired:

Class I. Preservation of life in case of fire.

Class II. All apparatus, engines, etc., for the preservation of life in or on water, or for the prevention of danger to the same.

Class III. Apparatus for the prevention of accidents in crowded thoroughfares, tram-ways, and railways.

Class IV. Assistance in time of war.

Class V. Medical and sanitary arrangements for the preservation of public health.

Class VI. Means of prevention of accidents and of safety as applied to industry.

Class VII. Domestic and private medical arrangements.

Class VIII. Medicine, surgery—pharmacy in connection with the preceding classes.

Class IX. Institutions for improving the condition of the working classes.

Class X. Health in connection with agriculture.

TWELFTH CONGRESS OF THE ITALIAN SCIENTIFIC ASSOCIATION.

The twelfth congress of the Italian Scientific Association was held at Palermo, beginning on the 29th of August.

ROYAL SOCIETY'S CATALOGUE OF LEARNED SOCIETIES AND SCIENTIFIC PAPERS, 1864–73.

The catalogue of such memoirs and articles as have been issued during the decade from 1864 to 1873, in the publications of learned societies and scientific magazines, promised some time since, will be soon made ready for printing by the Royal Society of London. The necessary funds for its completion have been granted by the council of the society, and it is expected that the British government will furnish the means for printing it, as it did for the six volumes covering (in one series) the years 1800 to 1863. It seems that those six volumes cost in all £8936 12*s.*, of which £3720 15*s.* 6*d.* were spent in the preparation of the work for press, and defrayed by the Royal Society, and the rest was expended for printing, paper, and binding at the cost of the government. The work has been a public benefaction to all persons interested in scientific research, and the new volume will be eagerly looked for.

MEETING OF THE AMERICAN FISH-CULTURISTS' ASSOCIATION.

The fourth annual meeting of the American Fish-culturists' Association was held in New York on the 9th and 10th of February, 1875, and the proceedings have just been published under the direction of Mr. A. S. Collins, of Caledonia, New York, the secretary of the association. There was a large attendance present, and many interesting papers were presented.

The society is not limited to the United States, but includes quite a number of members from the Dominion, one of these, Mr. W. F. Whitcher, the Commissioner of Fisheries, being a member of the Executive Committee.

Among the most important papers presented were one by Mr. Frederick Mather, on the "Poisoning and Obstruction of Waters;" one by Seth Green, on "Stocking Depleted Waters;" by Samuel Wilmot, on "Aqua-culture and Fish Protection;" by Mr. Salter, on "Fish-culture in China, and the Chinese Shad;" by Thaddeus Norris, on the "Introduction of the Michigan Grayling into Eastern Waters;" and by James Worrall, on "Pennsylvania Fish-Ways."

There are at present about eighty members of the association.

PROCEEDINGS OF THE CENTENNIAL OF CHEMISTRY.

The proceedings of the Centennial of Chemistry, held August 1, 1874, at Northumberland, and published in the August, September, and December numbers of the *American Chemist*, 1874, have just been reproduced in a neat quarto volume of 211 pages, under the editorship of Professor H. C. Bolton. In addition to the account of the proceedings, there is a sketch of the life and labors of Priestley by Professor Henry H. Croft; an address at his grave by Professor Coppée; an address by T. Sterry Hunt, on "A Century's Progress in Chemical Theory;" by Professor J. Lawrence Smith, on "The Century's Progress in Industrial Chemistry." The most important component of the volume is an account of American contributions to chemistry, in an address by Professor Benjamin Silliman, containing a list of all American chemists for the past century, with a detailed enumeration of their memoirs.

NATIONAL PARK IN THE ISLAND OF MACKINAW.

One of the enactments of the recent Congress in the interest of the public was the setting aside of a large part of the island of Mackinaw, Michigan, as a national park, all of the land in that vicinity owned by the United States, with the exception of a certain portion required for military purposes, having been placed under the charge of the Secretary of War for the purpose in question, with the condition that all persons who shall settle on or occupy the same, excepting under conditions specified, shall be considered trespassers, and removed therefrom. It is made the duty of the Secretary of War to establish such regulations as he may think best for the proper protection and preservation of the trust. He is to provide for the preservation of the timber, the mineral deposits, natural curiosities, etc. He may, at his discretion, grant leases for a term not exceeding ten years, at places where the erection of buildings for the accommodation of visitors is desirable, and all the proceeds of said leases are to be expended in the construction of roads and bridle-paths. The wanton destruction of game and fish found within the limits of the park is to be provided against, and all trespassers are to be duly punished.

ANNUAL REPORT OF THE LIBRARIAN OF CONGRESS.

The annual report of the Librarian of Congress for 1874 has just been published. From this we learn that the additions during the year consisted of 15,405 books and 6272 parts of books and pamphlets, of which 1264 volumes and 1756 parts of volumes were received from the Smithsonian Institution, and 6840 volumes by copyright. The total number of copyrighted articles, including books, periodicals, musical compositions, dramatic compositions, photographs, engravings, and chromos, maps, charts, drawings, and prints, amounted to 29,674. The copyright entries for the year exceeded those of the previous year by 931. The amount paid into the Treasury on account of copyright fees was $13,524 78.

Mr. Spofford, the librarian, again calls the attention of

Congress to the great importance of a library building for the accommodation of the constantly increasing collections, which have already grown far beyond the bounds of the present library halls.

ADDITIONAL PAY TO THE SURVIVORS OF THE "POLARIS."

An act was passed by the recent Congress providing for the payment to the survivors of the *Polaris* in the arctic expedition under command of Captain Hall, their widows or minor children, of a sum of money, in addition to that already paid, equal to one year's pay which each would have been entitled to respectively, if continued in the service, under rules and regulations prescribed by the Secretary of the Navy for the said exploring expedition, and that the sum of $360 each be paid to the Esquimaux Joe and Hans.

The act further provides that if any sale, assignment, or transfer shall be made of any interest in the gratuity provided by this act, the amount so assigned shall revert to the government of the United States.

The act does not include Mrs. Hall in its provisions, as she has received the sum of $15,000 from the government for the manuscripts of Captain Hall.

THE LYELL MEDAL.

Sir Charles Lyell has left to the Geological Society of London the sum of $10,000, one third of the interest of which is to be applied annually to furnish a medal in bronze, called the Lyell medal, as a recognition on the part of the society of merit on the part of the medalist. The remainder of the interest is to be given in one or more portions, at the discretion of the Council, for the encouragement of geology or any of its allied sciences, either for traveling expenses or for a memoir or paper published. It is to be given without reference to the sex or nationality of the author, or the language in which it is written.—12 *A*, *April* 1, 1875, 434.

ANNUAL RECORD OF PUBLICATIONS IN GEOLOGY, MINERALOGY, AND PALEONTOLOGY.

An annual record of publications in geology, mineralogy, and paleontology has been undertaken, to correspond in plan with the *Zoological Record*, so serviceable to naturalists. The first volume will be printed by the middle of 1875, to contain an account of publications for 1874. The work will probably occupy from two to three hundred pages, and be sold at 10*s.* 6*d.* Among those who will take part in the work are Messrs. Carruthers, De Rance, D. Forbes, Professor Geikie, Professor T. R. Jones, L. C. Miall, Dr. H. A. Nicholson, Henry Woodward, and others. Authors of articles on the above-mentioned subjects are requested to forward copies for the purpose of having them properly noticed.—12 *A*, *Oct.* 22, 1874, 511.

LOAN EXHIBITION OF SCIENTIFIC APPARATUS.

The scientific department of the Committee of Council on Education, South Kensington, England, is preparing to make a loan exhibition of scientific apparatus in 1876, to begin on April 1st and last till the end of September. This will consist of instruments and apparatus employed for a variety of scientific purposes, as also of articles illustrating the progress of science and its application to the arts, with any specimens that may be supposed to have an interest on account of the persons who employed them. Drawings, photographs, etc., will also be admissible where the originals can not be sent. Special efforts are being made to render this collection complete, and Mr. W. Cunliffe Owen, director of the South Kensington Museum, has applied to various scientific establishments of this country—as the Smithsonian Institution—for such specimens as may be considered desirable in this connection.

LIST OF THE MERCHANT VESSELS OF THE UNITED STATES.

The Statistical Bureau of the Treasury Department has published a list of the merchant vessels of the United States, with the official numbers and signal letters awarded them—a volume of nearly six hundred pages. This contains, first, a list of the merchant vessels, alphabetically arranged; second, a list of the unrigged merchant vessels, alphabetically arranged; third, a list of sea-going vessels, with signal letters arranged in their regular order; fourth, a supplemental list of vessels, officially numbered, up to June 30, 1874; fifth, a list of vessels in the revenue service; sixth, a list of vessels belonging to the United States Navy in 1874; seventh, a complete list of the vessels of the United States Navy from 1797 to 1874, together with the lists and numbers of the line, staff, and other officers, both active and retired.

This report is the sixth full statement of the kind, required by an act of Congress of 1866, and contains a new and very important feature in the list of sea-going vessels, with the signal letters assigned them, by reference to which shipmasters can readily ascertain the name, tonnage, and home port of any vessel exhibiting her signals at sea.

INTERNATIONAL ASTRONOMICAL SOCIETY.

The sixth biennial meeting of the International Astronomical Society, founded in 1863 at Heidelberg, took place from the 13th to the 16th of August, at Leyden, and was opened by the president, O. Struve. The representatives appear to have been from Germany, Holland, Russia, Norway, Mexico, and Java, no French, English, or American names being recorded among those present. It was stated that the actual number of members is two hundred and thirty-five, embracing some of the most eminent names in astronomical annals. All the manuscripts of Professor Hansen had been recently presented to the society. Professor Struve was re-elected president for the coming year.

ANNUAL REPORT OF THE PEABODY MUSEUM OF ARCHÆOLOGY AND ETHNOLOGY.

The annual report of the trustees of the Peabody Museum of Archæology and Ethnology, brought up to April, 1875, comes appropriately dressed in mourning, on account of the death of its first director, Professor Jeffries Wyman, whose loss American science was called upon to deplore some time in September, 1874. After his decease the establishment was placed in charge of Professor F. W. Putnam, who has made up the present report in part from Professor Wyman's notes. It is well known that the Peabody Museum is extremely rich in objects of European prehistoric civilization. Indeed, it may almost be said that no one European museum has a larger and more varied collection of specimens belonging to the Stone Age of different parts of that continent. Its additions of most note, however, during the past year, consist in a number of earthenware dishes and vases, obtained near

New Madrid, Missouri, and elsewhere in that state, by Professor J. C. Swallow, and purchased from him for the sum of $1500. An immense variety of curious vases, pots, and other articles was obtained, the former contracted at the top, where human and animal figures of considerable excellence of execution are represented. A very interesting portion of the report is that in which Professor Putnam details the results of his visits to sundry caves in Kentucky and Indiana, and especially his discovery, in places far removed from the entrance, of foot-prints of the prehistoric races made in the dust, together with sandals of grass, various articles of dress, and clothing materials.

P. NECROLOGY.

In this list are embraced some names of noteworthy persons deceased in 1874, but not included in the *Annual Record* for that year.

Adami, Carl Ludwig. Known in Germany as a manufacturer of globes. Died at Potsdam, January 23d.

Aitken, W. C. A member of the Society of Arts, and author of many papers on ancient and modern metal-working. Died in Birmingham, March 24th.

Andree, Dr. Karl T. Author of valuable geographical works; editor or translator of several treatises of a similar character, the most important being the "Geography of the Commerce of the World." Died August 16th, aged sixty-eight.

Argelander, Professor W. A. An eminent German astronomer. Superintendent of the Observatory of Bonn. Author of a celestial atlas comprising all the stars to those of the tenth magnitude. Born at Munich, March 22d, 1790. Died at Bonn, February 17th, aged almost eighty-five.

Barnes, M. Thomas. An African traveler and geologist. Died May 8th, on his way toward the Tattin.

Baudelot, Professor E. A distinguished French physiologist and naturalist. Author of several papers on the anatomy and physiology of the mollusks and radiates. Died February 23d, at the age of forty.

Becker, Carl L. C. Well known in England as a constructor of electrical and physical apparatus. Born in 1821. Settled in London in 1845.

Brasseur de Bourbourg, Abbé. A distinguished traveler, especially zealous in the study of the archæology of the New World. Author of "The History of the Civilization of the Ancient Mexicans and Central Americans;" as also of a large number of memoirs illustrating his discoveries. Born at Bourbourg, in France, in 1814. Died at Nice, January 8th, 1874.

Bradley, Dr. Leverett. A well-known inventor and manufacturer of practical electrical devices, such as telegraph machines, helices, etc. Died at Jersey City, September 6th, at the age of seventy-six.

Burkart, Dr. J. H. Author of travels in Mexico and of a geological map of that country. Died at Bonn, in Germany, in November, at the age of seventy-six.

Cairns, Professor. As a chemist his researches were especially upon the sulphur compounds, the oxysulphides of phosphorus, etc. Died at Marburg, April 17th, at the age of forty-six.

Campbell, Dr. Archibald. A British medical officer, resident at Darjeeling, in India, the sanitarium for the British army in Bengal. A high authority on the geography, natural history, ethnology, and geology of India and Central Asia. Died in London in the seventieth year of his age.

Collomb, Edward. Treasurer of the Geological Society of Paris. A companion of Professor Agassiz in Alpine travel, and of Verneuil while studying the economical mineralogy of certain portions of Spain. Died in June.

D'Arrest, Professor Henri Louis. Professor of Astronomy at the Universities of Leipsic and of Copenhagen. Discoverer of several comets and an asteroid. Born at Berlin. Died June 14th, in the fifty-third year of his age.

Deshayes, G. B. An eminent and veteran conchologist of Paris. Died June 9th.

D'Halloy, D'Omalius. A Belgian geologist, and author of many memoirs on geological subjects. Born in Liege, February 16th, 1783. Died January 15th, at the age of ninety-two.

Diehl, Israel S. A zealous collector of objects of Natural History, and at one time United States Consul at Batavia. Aided in the introduction of a large number of Cashmere goats into the United States. Died near Gettysburg, in Pennsylvania, January 4th, at the age of forty-nine.

Doubleday, Henry. An authority on the subject of the Lepidoptera of Great Britain, and familiar with its general natural history. Died June 29th, in the sixty-seventh year of his age.

Dufour, General H. W. Well known to geographers from the topographical maps of Switzerland produced under his direction as chief of the Swiss general staff. Died at Geneva about the middle of July.

Findlay, A. G. An eminent geographer and author of many excellent maps and charts. Publisher of sailing directions for various parts of the world, to the amount of over 6000 pages. Born in London, January 6th, 1812. Died at Dover, May 3d, in the sixty-fourth year of his age.

Franklin, Lady. Distinguished as the wife of Sir John Franklin, and the companion of his geographical and other pursuits, from the date of her marriage, November 5th, 1828, until his departure on his last journey in 1845. She was devoted to the effort to secure the relief of or information respecting the fate of her husband even to the time of her own death, and was the only woman besides Mrs. Somerville who enjoyed the distinction of having the gold medal of the Royal Geographical Society conferred upon her. Died July 15th, at the age of eighty-three.

Goodenough, Commodore J. G. A British naval officer and geographer. Born in 1830. Entered the navy in 1844, on the *Collingwood*. Killed by a poisoned arrow while trying to open friendly intercourse with the natives of Santa Cruz Island, August 20th.

Gray, Dr. John Edward. The veteran zoologist of the British Museum, with which he was connected fifty years, and for thirty-five years its keeper.

Author of many voluminous zoological publications, one of the most conspicuous being "The Knowsley Menagerie." Born at Walsall in 1800.

Gurney, Sir Goldsworthy. The inventor of the Bude light, and of applications for ventilating fiery coal-pits and extinguishing fires in them by the steam jet.

Guthe, Hermann. Author of many excellent geographical text-books. Died at Munich, January 29th, 1874, in the fiftieth year of his age.

Hanbury, Daniel. A high authority in the matter of the history and sources of drugs, his "Pharmacographia" being his most important work. Died March 24th, in London, of typhoid fever, at the age of forty-nine.

Hardwicke, Robert. Publisher of many important scientific serial and other works. Died in London, March 8th.

Hays, William J. A prominent American artist, especially skilled in the delineation of wild animals. Died in New York, March 13th, at the age of forty-five.

Head, Sir Francis Bond. A well-known engineer, and at one time Lieutenant-Governor of Upper Canada. Author of several popular works of travel. Died in July, at the age of eighty-two.

Henwood, William J. A zealous investigator in reference to subterranean temperatures, mineral veins, the conducting power of various rocks, etc. Died in Penzance, August 5th, at the age of seventy-one.

Kiernan, Francis. An eminent zoologist and anatomist. An examiner for many years of the Royal College of Surgeons. Died December 31st, 1874, in the seventy-fifth year of his age.

Lankester, Dr. Edwin. One of the originators of the British Association. Editor of the *Quarterly Journal of Microscopical Science.* Publisher of many works on natural history, the best known being his "Half Hours with the Microscope." Born in 1814. Died at Margate, of diabetes, October 30th, in his sixty-first year.

Lapham, Dr. Increase A. Prominent as a naturalist, geologist, surveyor, and meteorologist. Founder of the Wisconsin Academy of Natural Sciences and Arts. Author of an important work upon "The Ancient Monuments of Wisconsin." Discoverer of many new species of shells. Born at Palmyra, N. Y., March 7th, 1811. Died at Milwaukee, September 14th, in the sixty-fifth year of his age.

Le Besque, M. The oldest correspondent of the Geometry Section in the Academy of Sciences of Paris. Died at Bordeaux, June 12th.

Le Font, Alexander de. Director of the Arcachon Museum. Distinguished for important discoveries in practical oyster-culture. Died at the age of forty-five.

Logan, Sir William E. An eminent mining engineer and geologist. Chief of the Geological Survey of Canada from 1842 to 1870. Born at Montreal, where he also died, at the age of seventy-eight, June 28th.

Long, Captain Thomas. The first to establish the existence of a large body of land in the Arctic Ocean north of Behring Strait, and called by him Wrangell Land. Died near Honolulu, August 8th.

Lyell, Sir Charles. A veteran in geological science, of which his works were the chief exponents. Published five editions of a work entitled "Principles of Geology," and several others upon the same science; "The Student's Manual of Geology" being a standard text-book. Also author of an important treatise on the "Geological Evidences of the Antiquity of Man." In recognition of his merits he was made the president and medalist of numerous societies. Born November 14th, 1797. Died February 22d, 1875, in the seventy-ninth year of his age.

Mason, Rev. Francis. Born at York, England. Missionary to Burmah in 1830. Author of many valuable works on that country. Died at Rangoon, March 3d, 1874, at the age of seventy-five.

Mathieu, Professor Claude Louis. Oldest member of the Academy of Sciences of Paris. Author of several scientific and literary works, and known especially in connection with the "Annual of the Bureau des Longitudes." Died March 5th, in the ninety-third year of his age.

Mauch, Dr. Carl. Known as an explorer in Africa. Died April 4th, in consequence of a fall from a window.

Maw, Henry L. The first Englishman to explore the Amazon from its source to its mouth. Born in 1801.

McDonald, Dr. William. Professor of Civil and Natural History for twenty-four years in the United Colleges of St. Andrews. Died January 1st, 1875.

Mohamed, Si Abdallah Ben. An eminent Arabian chemist. Died in Algiers, May 11th, at the age of thirty-two.

New, Charles. A missionary, the first person to ascend the snow-clad mountain of Kilima-njaro. Died during an expedition into the interior of Africa.

Nieto, José A. A member of the Entomological Society of France, and a well-known collector of Mexican insects, especially of Coleoptera. Died at Cordova, Mexico.

Oates, Frank. A recent traveler in Africa. Died of fever near the Makalake towns, February 5th, at the age of thirty-five.

Osborn, Admiral Sherrard. A well-known arctic traveler. A volunteer in the search for Sir John Franklin in the expedition of 1849. Entered the service of the Emperor of China in 1862. Returning to England, engaged in building iron-clad vessels. A zealous friend and promoter of arctic research. Born in 1822. Died in London, May 8th, at the age of fifty-three.

Pease, Charles. An amateur naturalist; obtained the first specimen of *Dendroica kirtlandiæ*. Member of the Western Union Telegraph expedition to the Yukon River in 1865. Died at Cleveland, June 11th.

Peschel, Dr. Oscar. An eminent German geographer. Editor of *Das Ausland* for twenty years. Professor in the University of Leipsic. Author of many geographical works. Died in September at Leipsic.

Plath, Dr. Johann Heinrich. An eminent Chinese scholar. Author of many papers on Oriental subjects. Died November 16th, at Munich, at the age of seventy-three.

Reslhuber, Professor. Director of the observatory at Kremsmunster, in Austria. Died in September, in the sixty-eighth year of his age.

Roberts, Edward. An architect and antiquary. Honorary Secretary of the British Archæological Association. Died in October, in the fifty-seventh year of his age.

Roome, James H. A taxidermist and collector of objects of natural history. Died in New York, January 20th, at the age of sixty-five.

Scherer, Carl J. A. T. A well-known mineralogist and metallurgist. Author of many memoirs on chemistry, mineralogy, and geology, as well as upon iron-smelting and the blowpipe. Died at Freiburg, August 20th, at the age of about sixty-two.

Schott, Dr. Arthur. A zealous explorer, especially in Texas, Mexico, and Yucatan, and the Isthmus of Darien, and collector of objects of natural history, and the discoverer of many new species of animals and plants. Died at Georgetown, District of Columbia, July 26th, in the sixty-seventh year of his age.

Schrötter, Professor A. Perpetual Secretary of the Academy of Sciences of Vienna, and Master of the Mint. Author of many important chemical discoveries. Died April 15th, at the age of seventy-three.

Schwabe, H. H. Noted formerly for astronomical researches. Discoverer of the periodicity of the solar spots. Died at Dessau, April 11th, in the eighty-fifth year of his age.

Seguin, Sen., M. Correspondent in the section of Mechanics in the Academy of Sciences of Paris. Died at Annonay, February 24th, in the eighty-ninth year of his age.

Silveria, Conseiller Joaquim Henriques Tradessá Da. Director of the Meteorological Observatory at Lisbon. Died May 21st.

Smirke, Sir E. Distinguished for his knowledge of manorial and territorial rights and customs.

Sundevall, Professor Carl J. Distinguished as an explorer and a naturalist. Author of numerous zoological works. Curator of the National Museum at Stockholm. Born in 1801. Died at the age of seventy-four.

Thuret, M. An eminent French botanist, and a voluminous writer, especially upon the physiology and reproduction of the algæ. Died May 10th.

Tillman, Professor Samuel D. A zealous student of physical and experimental science. A member and officer of the American Institute of New York. Died September 4th, at the age of seventy-two.

Timbs, John. Editor of "The Year-Book of Facts." Died in London, in March, at an advanced age.

Waldeck, Baron J. F. de. A well-known traveler in Africa and America, and distinguished as an artist. Born in Prague; died in Paris, April 30th, at the age of *one hundred and nine!*

Walker, Francis. An eminent entomologist, long connected with the British Museum. Author of several works upon the diptera, etc. Died October 5th.

Webster, Thomas. An eminent patent lawyer of London. Died June 3d, in the sixty-fifth year of his age.

Wheatstone, Sir Charles. Professor of Experimental Philosophy in King's College, London. Discoverer of important practical applications in electrical science. Born in 1802. Died October 20th.

Willis, Professor R. Known as filling the chair of Jackson Professor at Cambridge, England. Died early in March.

Wilson, William Parkinson. Professor of Mathematics in Melbourne University, at which place he died, December 11th, 1874.

Winlock, Professor Joseph. Director of the observatory of Harvard College. Distinguished as an astronomer, and as an inventor of devices for improving the methods and qualities of astronomical manipulation. Died June 11th, at the age of forty-nine.

Zetterstedt, Professor Johann Wilhelm. An eminent Swedish entomologist, for many years Professor of Natural History at Lund. Died at Stockholm.

Q. BIBLIOGRAPHY.

SELECT WORKS ON SCIENCE PUBLISHED DURING 1875.

The following list of books relating to the several departments of science contains only the smaller portion of those published during the past year, but, it is believed, embraces the most important. The limitations of the *Record* preclude an exhaustive bibliographical enumeration or plan; nor, indeed, is this required by readers. Works only have been introduced that have features of general interest to commend them, especially such as have been more or less favorably noticed in the principal journals devoted to general science, and mention will be found of the places in the several journals where criticisms are contained. These references will serve in lieu of the critical notices which were proposed in the previous volume for the present *Record;* experience having shown that, in order to do justice to the several works and to ourselves, more space would be required than could be well spared for the purpose.

Whenever the volumes themselves were accessible, the titles and collations have been taken directly from them. In many cases, however, the compiler has been obliged to depend solely on the titles contained in the journals in which the volumes have been noticed, or upon booksellers' announcements. All the scientific works sent to the editor of the *Record* have been, and will hereafter be enumerated, whether specially noticed in the journals in question or not. The responses to the invitation for the transmission of copies to the editor for notice have been numerous, but many important publications have been withheld. In the interest of accuracy and completeness of enumeration, the editor renews his request for copies of new works for notice in future numbers of the *Record's* Bibliography.

For the notices of books, those journals have been referred to which are most generally accessible to ordinary readers on account of the nature of their circulation. They are:

(1.) The Academy: a Record of Literature, Science, and Art. London. (Weekly.)

(2.) The American Journal of Science and Art. Editors and Proprietors, James D. Dana, B. Silliman, and E. S. Dana (etc.). Third series. Vol. IX.—(Whole number, CIX.) Nos. 49–54, January to June, 1875 (et seq.) New Haven: Editors. 1875. (Published monthly, at $6 per annum.)

(3.) Nature: a Weekly Illustrated Journal of Science. London.

(4.) The Popular Science Monthly. Conducted by E. L. Youmans. Vol. VI. November, 1874, to April, 1875 (etc.). New York: D. Appleton and Company, 549 and 551 Broadway. 1875. (Published monthly, at $5 per annum.)

GENERAL SCIENCE.

GENERAL AND MISCELLANEOUS.

Becker (Bernard H.). Scientific London. New York: D. Appleton & Co. 1875. (viii. 340 pp., 12mo. Price, $1 75.)
[Popular (The) Science Monthly, VI., April, 1875, pp. 751, 752.]

Galton (Francis). English Men of Science; their Nature and Nurture. New York: D. Appleton & Co. 1875. (xii. 206 pp., 12mo. Popular Science Series.)
[Popular (The) Science Monthly, VII., 235–237, 18/5.]
[Am. Journ. S. and A. (3), X., 78, 1875.]

Great Britain. Royal Commission on Scientific Instruction and the Advancement of Science: Sixth, Seventh, and Eighth Reports. London. 1875.
[The Academy, August 21, 1875, pp. 199, 200; 227, 228; 251, 252.]

Half-hour Recreations in Popular Science. Boston: Estes & Lauriat. (Nos. 13–15.)
[Popular (The) Science Monthly, VIII., 377, 1875.]

Hartwig (G.). The Aërial World. A Popular Account of the Phenomena and Life of the Atmosphere. New York: D. Appleton & Co. 1875. (Price, $6 00.)
[Popular (The) Science Monthly, VII., 623, 1875.]

Holland (Sir Henry). Fragmentary Papers on Science and other Subjects. By the late Sir Henry Holland, Bart. Edited by his Son, Rev. Francis J. Holland. London: Longmans. 1875.
[Nature, XII., 181, 182, 1875.]

Hunt (Thomas Sterry). Chemical and Geological Essays. Boston: J. R. Osgood and Company. 1875. (489 pp., 12mo, $3 00.)
[Popular (The) Science Monthly, VI., 372, 1875.]
[The Academy, Sept. 25, 1875, pp. 335, 336.]

Neumayer (Dr. G., Editor). Anleitung zu wissenschaftlichen Beobachtungen auf Reisen mit besonderer Rücksicht auf die Bedürfnisse der Kaiserlichen Marine. Berlin: Oppenheim. 1875.
[Nature, XI., 321, 322, 1875.]

Papillon (Fernand). Nature and Life. Facts and Doctrines relating to the Constitution of Matter, the New Dynamics, and the Philosophy of Nature. By Fernand Papillon. Translated from the Second French edition by N. R. MacDonough, Esq. New York: D. Appleton & Co. 1875. (12mo, v. 363 pp., $2 00.)
[Am. Journ. S. and A. (3), IX., 480, 1875.]
[Popular (The) Science Monthly, VII., 114–116, 1875.]

Routledge (Robert). Discoveries and Inventions of the Nineteenth Century. With numerous Illustrations. London: George Routledge and Sons. 1876. (594 pp.)
[Nature, XIII., 45, 1875.]

Science Lectures for the People, delivered in Manchester. First, Second, Third, Fourth, Fifth, and Sixth Series. 1866–74. Manchester: Heywood. (8 Vols.)
[Nature, XIII., 82, 83, 1875.]

Unseen (The) Universe; or, Physical Speculations on a Future State. London: Macmillan & Co. 1875. (12mo, $1 00.)
[Popular (The) Science Monthly, VII., 492–494, 1875.]

COLLECTIONS.

International (The) Scientific Series. New York: D. Appleton & Co. 1875. Viz.:

- No. XII.—The History of the Conflict between Religion and Science. By John William Draper, M.D., LL.D.
- No. XIII.—The Doctrine of Descent, and Darwinism. By Professor Oscar Schmidt. With 26 wood-cuts.
- No. XIV.—The Chemistry of Light and Photography. By Dr. Hermann Vogel. With 100 Illustrations.
- No. XV.—Fungi: their Nature and Uses. By M. C. Cooke, M.A., LL.D. Edited by the Rev. M. J. Berkeley, M.A., F.L.S.
- No. XVI.—The Life and Growth of Language. By Professor W. D. Whitney, of Yale College.
- No. XVII.—Money and the Mechanism of Exchange. By W. Stanley Jevons, M.A., F.R.S.

Popular Science Series. New York: D. Appleton & Co. 1875. Viz.:

Cazelles (Dr. M. E.). Outline of the Evolution Philosophy. Translated from the French, by the Rev. O. B. Frothingham. With an Appendix, by E. L. Youmans, M.D.

Galton (Francis, F.R.S.). English Men of Science: their Nature and Nurture.

Quatrefages (A. de). The Natural History of Man: a Course of Elementary Lectures. Translated from the French, by Eliza Youmans. With an Appendix.

Smith (Edward, M.D., F.R.S.). Health: a Hand-book for Households and Schools.

Taylor (Sedley, M.A.). The Science of Music; or the Physical Basis of Musical Harmony.

CYCLOPÆDIAS: GENERAL.

American (The) Cyclopædia: a Popular Dictionary of General Knowledge. Edited by George Ripley and Charles A. Dana. Vol. X. [-XIV.], Kinglet [-Shoe]. New York: D. Appleton and Company. 1875. 8vo.

Chambers's Encyclopædia, a Dictionary of Useful Knowledge for the People. Illustrated with Maps and numerous Wood Engravings. Revised edition. Ten Vols. Edinburgh and London: W. & R. Chambers. 1874. 8vo.
[Nature, XIII., 42, 43, 1875.]

Encyclopædia (The) Britannica: a Dictionary of Arts, Sciences, and General Literature. Ninth edition. Vol. I. [-III.], A [-Boi-]. Edinburgh: Adam and Charles Black. 1875. 4to.
[Nature, XI., 343–345; XII., 308–310, 1875; XIII., 221, 222, 1876.]

Johnson's New Universal Cyclopædia: a Scientific and Popular Treasury of Useful Knowledge. Illustrated with Maps, Plans, and Engravings. Editors-in-chief, Frederick A. P. Barnard and Arnold Guyot. . . . Not to exceed Four Volumes, including Appendix. Vol. II., F to L. A. J. Johnson & Son, New York: W. D. Cummings, Pittsburg, Pa.; C. F. Alden, Boston, Mass.; H. D. Watson, San Francisco, Cal. 1875. 8vo.

Zell's Popular Encyclopedia and Universal Dictionary. [Nos. 1 to 25, A–Iran.] Edited by L. Colange, LL.D. New and Revised Edition. Philadelphia: Baker, Davis, & Co. 1875. 4to.

CYCLOPÆDIAS: TECHNICAL.

Knight's American Mechanical Dictionary: being a Description of Tools, Instruments, Machines, Processes, and Engineering; History of Inventions; General Technological Vocabulary; and Digest of Mechanical Appliances in Science and the Arts. By Edward H. Knight. Illustrated with upward of Five Thousand Engravings. Vol. II., Eva to Pan. New York: J. B. Ford and Company. 1875. 8vo.

Ure (Dr. Andrew). Ure's Dictionary of Arts, Manufactures, and Mines. By Robert Hunt, F.R.S., Keeper of Mining Records, &c., &c., assisted by F. W. Rudler, F.G.S., and by numerous Contributors eminent in Science and familiar with Manufactures. Seventh edition. In Three Volumes. London: Longmans. 1875. 8vo.
[Nature, XII., 182, 1875.]

PERIODICALS.

SOCIETIES.

(General.)

American Association for the Advancement of Science. Proceedings of the American Association for the Advancement of Science. Twenty-third Meeting, held at Hartford, Conn., August, 1874. Salem. 1875. 8vo.
[Popular (The) Science Monthly, VII., 495, 496, 1875.]

British Association for the Advancement of Science. Report of the forty-fourth meeting of the British Association for the Advancement of Science. London: J. Murray. 1875. 8vo.

(American.)

Albany Institute. Transactions of the Albany Institute. 8vo.

Boston: American Academy of Arts and Sciences. Memoirs of the American Academy of Arts and Sciences. Cambridge and Boston. 4to.

——— Proceedings of the American Academy of Arts and Sciences. Cambridge and Boston. 8vo.
[Popular (The) Science Monthly, VII., 118, 119, 1875.]

Boston Society of Natural History. Memoirs of the Boston Society of Natural History. 4to.

——— Proceedings of the Boston Society of Natural History. 8vo.

Buffalo Society of Natural Sciences. Bulletin of the Buffalo Society of Natural Sciences. 8vo.

Cambridge: Harvard University. Bulletin of the Bussey Institution. (Jamaica Plain, Boston.)

Minneapolis: Minnesota Academy of Sciences. Bulletin of the Minnesota Academy of Natural Sciences for 1875.

New Haven: Connecticut Academy of Arts and Sciences. Transactions of the Connecticut Academy of Arts and Sciences. 8vo.

New York (Lyceum of Natural History in). Annals of the Lyceum of Natural History in New York. 8vo.

New York: Torrey Botanical Club. Bulletin of the Torrey Botanical Club. 8vo.

Philadelphia (Academy of Natural Sciences of). Journal of the Academy of Natural Sciences of Philadelphia. Second Series. 4to.

——— Proceedings of the Academy of Natural Sciences of Philadelphia. Third Series. 8vo.

Philadelphia: American Philosophical Society. Proceedings of the American Philosophical Society, held at Philadelphia, for Promoting Useful Knowledge. 8vo.

——— Transactions of the American Philosophical Society, held at Philadelphia, for Promoting Useful Knowledge. New Series. 4to.

Philadelphia: Franklin Institute. The Journal of the Franklin Institute, devoted to Science and the Mechanic Arts. Edited by William H. Wahl, Ph.D., assisted by the Committee on Publication. Philadelphia: published by the Franklin Institute at their Hall. 8vo.

St. Louis (Academy of Science of). The Transactions of the Academy of Science of St. Louis. 8vo.

Salem: Essex Institute. Bulletin of the Essex Institute. 8vo.

——— Proceedings of the Essex Institute. 8vo.

Salem: Peabody Academy of Science. Memoirs of the Peabody Academy of Science. 8vo.

——— Eighth Annual Report of the Trustees of the Peabody Academy of Science for the Year 1875. Salem. 8vo.

San Francisco: California Academy of Sciences. Proceedings of the California Academy of Sciences. 8vo.

Washington (Philosophical Society of). Bulletin of the Philosophical Society of Washington: Published by the co-operation of the Smithsonian Institution. 8vo.

Washington: Smithsonian Institution. Contributions to Knowledge. 4to.

——— Smithsonian Miscellaneous Collections. 8vo.

——— Annual Report of the Board of Regents of the Smithsonian Institution. 8vo.

Wisconsin Academy of Sciences, Arts, and Letters. Transactions of the Wisconsin Academy of Sciences, Arts, and Letters. 8vo.

(*British.*)

Dublin: Royal Irish Academy. Transactions of the Royal Irish Academy.

——— Proceedings of the Royal Irish Academy.

Edinburgh (Royal Society of). Transactions of the Royal Society of Edinburgh.

——— Proceedings of the Royal Society of London.

London Chemical Society. Journal of the Chemical Society, containing the Papers read before the Society, and Abstracts of Chemical Papers published in other Journals. Monthly. London.

London Royal Society. Philosophical Transactions of the Royal Society of London.

——— Proceedings of the Royal Society of London. 1873.

London (Zoological Society of). Proceedings of the Scientific Meetings of the Zoological Society of London. London.

MAGAZINES.

(*American.*)

American (The) Chemist. A Monthly Journal of Theoretical, Analytical, and Technical Chemistry. New York. 4to.

American Journal of Pharmacy. Published by Authority of the Philadelphia College of Pharmacy. Edited by John M. Maisch. 8vo.

American (The) Journal of Science and Arts. Editors and Proprietors, Professors James D. Dana and B. Silliman [etc.]. New Haven: Editors. 8vo.

American (The) Naturalist, and Illustrated Magazine of Natural History. Edited by A. S. Packard, Jr., and F. W. Putnam. Volume IX. Salem, Mass.: Peabody Academy of Science. 8vo, $4 00 a Year.

Canadian Entomologist. Volume VII. Edited by William Saunders, London, Ontario. London: Free Press Printing Co., Richmond Street. 8vo.

Canadian (The) Journal of Science, Literature, and History. Conducted by the Editing Committee of the Canadian Institute. Toronto: Printed for the Canadian Institute. 8vo.

Canadian (The) Naturalist. Montreal. 8vo.

Cincinnati (The) Quarterly Journal of Science. Editor and Proprietor, S. A. Miller, Cincinnati. Vol. II. 8vo.

Coal (The) and Iron Record. A Weekly Journal devoted to the Coal and Iron Trades. New York. 4to.

Mining and Scientific Press. An Illustrated Journal of Mining, Popular Science, and General News. San Francisco: Dewey & Co. Fol.

Naturaliste (Le) Canadien. Bulletin de recherches, observations, et découvertes se rapportant á l'histoire naturelle du Canada. Rédacteur: M. l'Abbé Provancher. Quebec: Bureau du "Naturaliste Canadien," No. 82 Rue Lamontagne. 8vo.

Popular (The) Science Monthly. Conducted by E. L. Youmans. New York: D. Appleton & Co. 8vo.

Psyche. Organ of the Cambridge Entomological Club. Edited by B. Pickman Mann. Cambridge.

Scientific American. A Weekly Journal of Practical Information, Art, Science, Mechanics, Chemistry, and Manufactures. New York: Munn & Co. Fol.

(*British.*)

Academy (The): a Record of Literature, Learning, Science, and Art. Semi-Monthly. London.

Annals (The) and Magazine of Natural History. Monthly. London.

Chemical (The) News and Journal of Physical Science. Weekly. London.

London, Edinburgh, and Dublin Philosophical Magazine. Monthly. London.

Nature: a Weekly Illustrated Journal of Science. London.

Popular (The) Science Review. Quarterly. London.

MATHEMATICS.

London: Association for the Improvement of Geometrical Teaching. Syllabus of Plane Geometry (corresponding to Euclid, Books I.-VI.). Prepared by the Association for the Improvement of Geometrical Teaching. London: Macmillan. 1875.
[Nature, XIII., 102, 103, 1875.]

Walter (William). A Course in Descriptive Geometry for the Use of Colleges and Scientific Schools. Boston: L. Prang & Co.
[Am. Journ. S. and A. (3), X., 488, 1875.]

ASTRONOMY.

DICTIONARY.

Klein (Hermann J.). Populäre Astronomische Encyclopädie. Astronomisches Handwörterbuch. Eine lexicographisch geordnete Erklärung der in der Himmelskunde und den darauf bezüglichen Theilen der übrigen Naturwissenschaften vorkemmenden Begriffe, und Ausdrücke nebst biographischen Notizen über die hierbei erwähnten Forscher. Für Freunde der Himmelskunde. Mit 58 Holzschnitten. Heilbronn: Verlag von Gefr. Henninger. 1874. (8vo, IV., 480 pp.)

GENERAL.

Plummer (John Isaac). Introduction to Astronomy. For the Use of Science Classes and Elementary and Middle Class Schools. By John Isaac Plummer, Astronomical Observer to the University of Durham. New York: G. P. Putnam's Sons. (1873, 16mo, 174 pp., 1 pl.)
(Putnam's Elementary Science Series.)

Lockyer (J. Norman, F.R.S.). Astronomy. By J. Norman Lockyer, F.R.S., Correspondent of the Institute of France. With Illustrations. New York: D. Appleton and Company. 1875. (12mo, xv., 120 pp.)
(Science Primers.)

SOLAR SYSTEM.

Alexander (Stephen). Statement and Exposition of Certain Harmonies of the Solar System. Washington. 1875.
(Smithsonian Contributions to Knowledge, No. 280. Washington. 1875.)
[Popular (The) Science Monthly, VII., 624–626, 1875.]

STARS.

Herschel (Sir J. F. W.). A Catalogue of 10,300 Multiple and Double Stars, arranged in the Order of Right Ascension by the late Sir J. F. W. Herschel, Bart., and edited by the Rev. R. Main, M.A., F.R.S., Radcliffe Observer, and the Rev. C. Pritchard, M.A., F.R.S., Savilian Professor of Astronomy in the University of Oxford. London. 1874.
(Memoirs of the Royal Astronomical Society, Vol. XL.)
[Popular (The) Science Monthly, VII., 374, 375, 1875.]

NAUTICAL ASTRONOMY.

Evers (Henry, LL.D.). Theory and Practice of Navigation. By Henry Evers, LL.D., Professor of Mathematics and Applied Science, Plymouth. 1873. New York: G. P. Putnam's Sons. (16mo, 126 pp.)
(Putnam's Elementary Science Series.)

Evers (Henry, LL.D.). Elementary Treatise on Nautical Astronomy. For the Use of Science Classes and Seamen. By Henry Evers, LL.D., Professor of Mathematics and Applied Science, Charles Science School, Plymouth. New York: G. P. Putnam's Sons. (1873, 16mo, 144 pp.)
(Putnam's Elementary Science Series.)

METEOROLOGY.

Blasius (William). Storms; their Nature, Classification, and Laws, with the Means of Predicting them by their Embodiments, the Clouds. Philadelphia: Porter & Coates. (8vo, 342 pp. Price, $2 50.)
[Popular (The) Science Monthly, VII., 501, 1875.]

Meteorological Committee. Report on Weather Telegraphy and Storm Warnings to the Meteorological Congress at Vienna, by a Committee appointed at the Leipzig Conference.

——— Report of the Proceedings of the Conference on Maritime Meteorology, held in London, 1874. Published by Authority of the Meteorological Committee, 1875.
[Nature, XII., 493, 1875.]

Sargeaunt (Captain R. A.). Notes on the Climate of the Earth, Past and Present. By Captain R. A. Sargeaunt, Royal Engineers. London: Smith, Elder, & Co. 1875.

Tice (John T.). Elements of Meteorology. Part II., Meteorological Cycles. St. Louis. 1875. (208 pp. Price, $2 50.)
[Popular (The) Science Monthly, VIII., 373, 374, 1875.]

PHYSICS.

GENERAL.

Ganot. Natural Philosophy for General Readers and Young Persons. Translated from Ganot's "Cours élémentaire de Physique," by P. Atkinson, Ph.D. Second edition. London: Longmans.
[The Academy, Sept. 25, 1875, p. 337.]

Weinhold (A. F.). Introduction to Experimental Physics. By A. F. Weinhold, Professor in the Royal Technical School at Chemnitz. Translated and Edited by B. Loewy, F.R.A.S., with a Preface by Prof. G. C. Foster, F.R.S. London: Longmans. 1875.
[Nature, XI., 482–485, 1875.]

MECHANICS.

Magnus (Philip). Lessons in Elementary Mechanics, introductory to the Study of Physical Science, with numerous Exercises. London: Longmans, Green, & Co. 1875.
[Nature, XII., 394, 395, 1875.]

Nystrom (John W., C. E.). A new Treatise on Elements of Mechanics, establishing strict Precision in the Meaning of Dynamical Terms, accompanied with an Appendix on Duodenal Arithmetic and Metrology, by John W. Nystrom, C.E. Philadelphia: Porter & Coates, 822 Chestnut Street, Published for the Author. 1875. (8vo, 352 pp.)
[Am. Journ. S. and A. (3), X., 479, 1875.]
[Popular (The) Science Monthly, VII., 243, 1875.]

HEAT.

Gordon (J. E. H.). An Elementary Book on Heat. London: Macmillan & Co. 1875.

LIGHT.

Lommel (Dr. Eugene). The Nature of Light; with a General Account of Physical Optics. By Dr. Eugene Lommel, Professor of Physics in the University of Erlangen. With 148 Illustrations and a Table of Spectra in Chromo-lithography. London: Henry S. King & Co. 1875.
[Nature, XIII., 62–65, 1875.]

Spottiswoode (William). Polarization of Light. New York: Macmillan. (137 pp. Price, $1 00.)
[Popular (The) Science Monthly, VI., April, 1875, pp. 754.]

Tyndall (John). Six Lectures on Light, delivered in America in 1872–73. Second edition. London: Longmans & Co. 1875.
[Nature, XII., 211, 1875.]

ACOUSTICS.

Martineau (C. A.). Chapters on Sound, for Beginners. London: The Sunday-School Association; Manchester: Johnson and Rawson. 1875.
[Nature, XII., 164, 165, 1875.]

Tyndall (John). Sound. Third edition. London: Longmans & Co. 1875.
[Nature, XII., 211, 1875.]

MAGNETISM AND ELECTRICITY.

Angell (John). Elements of Magnetism and Electricity. With Practical Instructions for the Performance of Experiments, and the Construction of Cheap Apparatus. By John Angell, Senior Science-master, Manchester Grammar School. With 120 Illustrations. New York: G. P. Putnam's Sons. 1873. (16mo, 176 pp.)
(Putnam's Elementary Science Series.)

Broun (John Allan). Observations of Magnetic Declination made at Trevandrum and Agustia Malley in the Observatories of His Highness the Maharajah of Travancore, G.C.S.I., in the Years 1852 to 1869. Vol. I. Discussed and edited by John Allan Broun, F.R.S., late Director of the Observatories. London: Henry S. King & Co. 1875.
[Nature, XII., 163–165, 1875.]

Sprague (John T.). Electricity; its Theory, Sources, and Applications. London: E. F. N. Spon. 1875.
[Nature, XII., 144, 145, 1875.]

Toronto Observatory. Abstracts and Results of Magnetical and Meteorological Observations at the Magnetic Observatory, Toronto, Canada, from 1841 to 1871. Toronto. 1875.
[Nature, XII., 474, 475, 1875.]

CHEMISTRY.

GENERAL.

Barff (F. S.). Elementary Chemistry. London: Edward Stanford. 1875.
[Nature, XII., 185, 1875.]

Hinrichs (Dr. Gustavus). The Principles of Chemistry and Molecular Mechanics. Davenport, Iowa: Day, Egbert, & Fidlar. 1874.
[Nature, XII., 288, 289, 1875.]

Watts (Henry). A Dictionary of Chemistry and the Allied Branches of other Sciences. Second Supplement. London: Longmans, Green, and Co. 1875.
[Nature, XII., 327, 328, 1875.]

CHEMICAL TECHNOLOGY.

Hofmann (A. W.). Bericht über die Entwicklung der Chemischen Industrie während desletzen Jahrzehends; im Verein mit Freunden und Fachgenossen erstattet von Dr. A. W. Hofmann. Autorisirter Abdruck aus dem Amtlichen Bericht über die Wiener Weltausstellung im Jahre 1873. Vol. III., Part I. Braunschweig: Fr. Vieweg und Sohn. 1875.
[Nature, XII., 365, 366, 1875.]

Prescott (Albert). Chemical Examination of Alcoholic Liquors. A Manual of the Constituents of the Distilled Spirits and Fermented Liquors of Commerce, and their Qualitative and Quantitative Determination. New York: D. Van Nostrand. (108 pp. Price, $1 50.)
[Popular (The) Science Monthly, April, 1875, VI., 755.]

Richardson (Benjamin W.). On Alcohol. A Course of Six Canton Lectures delivered before the Society of Arts. London: Macmillan.
[The Academy, Sept. 25, 1875, p. 337, 338.]

Vogel (Dr. Hermann). The Chemistry of Light and Photography. By Dr. Hermann Vogel, Professor in the Royal Industrial Academy of Ber-

lin. With 100 Illustrations. New York: D. Appleton and Company. 1875. (12mo, xii. 288 pp., with 94 figs., 6 pls.)
(The International Scientific Series [Volume XIV.]).
[Popular (The) Science Monthly, April, 1875, VI., 751.]

MINERALOGY.

Brush (George J.). Manual of Determinative Mineralogy, with an Introduction on Blow-pipe Analysis. New York: John Wiley and Son. 1875. (8vo.)
[Nature, XII., 183–185, 1875.]

Dana (James D.). Second Appendix to Dana's Mineralogy. By Edward S. Dana. New York: John Wiley and Son. 1875. (8vo, 66 pp.)
[Am. Journ. S. and A. (3), X., 60, 1875.]

Fuchs (Dr. C. W. C.). Practical Guide to the Determination of Minerals by the Blow-pipe. Translated and edited by F. W. Danby, F.G.S. London: Field & Tuer. 1875. (8vo. Price, $2 50.)
[Popular (The) Science Monthly, VII., 627, 1875.]

Ross (Major W. A.). Pyrology; or, Fire Chemistry. London: E. & F. N. Spon. 1875.
[Nature, XIII., 164, 165, 1875.]

Scheerer (Dr. Theodore) and H. F. Blanford. An Introduction to the Use of the Mouth Blow-pipe. Third edition. London: Frederick Norgate. 1875. (8vo.)
[Nature, XIII., 164, 165, 1875.]

GENERAL BIOLOGY.

SYSTEMATIC.

Huxley (T. H.). A Course of Practical Instruction in Elementary Biology. By T. H. Huxley, LL.D., Sec. R. S., assisted by H. N. Martin, B.A., D.Sc. London: Macmillan & Co. 1875.
[Nature, XII., 530–532, 1875.]

MacGinley (Thomas C.). An Introduction to the Study of General Biology. Designed for the Use of Schools and Science Classes. By Thomas C. MacGinley, Principal of Croagh National School, County Donegal. With 124 Illustrations. New York: G. P. Putnam's Sons. 1873. (16mo, 200 pp.)
[Putnam's Elementary Science Series.]

Stevenson (Sarah Hackett). Boys and Girls in Biology; or, Simple Studies of the Lower Forms of Life; based upon the latest Lectures of Prof. T. H. Huxley, and published by his permission. By Sarah Hackett Stevenson. Illustrated by Miss M. A. I. Macomish. New York: D. Appleton & Co. 1875. (12mo, 186 pp., with 151 figs.)

AQUARIUM.

Kent (W. Saville). Official Guide-book to the Manchester Aquarium. By the Curator, W. Saville Kent, F.L.S., F.Z.S. Third edition. Twentieth thousand. Manchester. 1875.
[Nature, XIII., 85, 1875.]

EVOLUTION.

Bastian (H. Charlton). Evolution and the Origin of Life. London: Macmillan & Co. 1874.
[The Academy, 1875, pp. 15, 16, 41, 43.]

Cazelles (Dr. M. E.). Outline of the Evolution Philosophy. By Dr. M. E. Cazelles. Translated from the French, by the Rev. O. B. Frothingham. With an Appendix, by E. L. Youmans, M.D. New York: D. Appleton & Co. . . . 1875. (12mo, 167 pp.)
(Popular Science Series.)

Dodel (Arnold). Die neuere Schöpfungs-geschichte nach dem gegenwärtigen Stande der Naturwissenschaften. Leipzig: Brockhaus. 1875.
[Nature, XIII., 265, 266.]

Fiske (John). Outlines of Cosmic Philosophy, based on the Doctrine of Evolution, with Criticisms on the Positive Philosophy. In Two Volumes. Boston: J. R. Osgood & Co. 1874. (8vo, Vol. I., 465 pp.; Vol. II., 528 pp. Price, $6 00.)
[Popular (The) Science Monthly, VI., 367–369, 1875.]
[Nature, XII., 267–270, 1875.]

Haeckel (Ernst). The History of Creation: or The Development of the Earth and its Inhabitants by the Action of Natural Causes. A Popular Exposition of the Doctrine of Evolution in general, and of that of Darwin, Goethe, and Lamarck in particular. From the German of Ernst Haeckel, Professor in the University of Jena. The Translation Revised by E. Ray Lankester, M.A., F.R.S., Fellow of Exeter College, Oxford. In Two Volumes. London: Henry S. King & Co. 1876.
[Nature, 1875.]

Ribot (Th.). Heredity: a Psychological Study of its Phenomena, Laws, Causes, and Consequences. From the French of Th. Ribot. London: Henry S. King & Co. 1875.
[Nature, XI., 503, 504, 1875.]
[Popular (The) Science Monthly, VII., 117, 118, 1875.]

ZOOLOGY.

GENERAL.

Blake (C. Carter). Zoology for Students. London: Daldy, Isbister, & Co. 1875.
[Nature, XII., 558, 1875.]

Carus (Jul. Victor) und C. E. A. Gerstaecker. Handbuch der Zoologie. Erster Bund, II. Halfte. Leipzig: Verlag von Wilhelm Engelmann. 1875. (8vo.)
[Nature, XII., 247–249, 1875.]

Dümling (Dr. Hermann). Illustrirtes Thierleben. Für Schule und Haus. Mit besonderer Berücksichtigung der americanischen Thiere. Die Säugethiere. Mit 10 Colorirten Tafeln, 4 Thontafeln und vielen Holzschnitten. Milwaukee, Verlag von Geo. Brumder. [1875.] (8vo, xvi. 349 pp.)
A worthless publication.

Morse (Edward S.). First Book of Zoölogy. New York: D. Appleton and Company, 1875. (12mo, xii. 190 pp., 158 cuts.)
[Am. Journ. S. and A. (3), X., 396, 397, 1875.]
[Popular (The) Science Monthly, VII., 115–117, 1875.]

Tenney (Sanborn). Elements of Zoölogy. New York: Scribner, Armstrong, & Co. 1875. (12mo, 503 pp., with 750 wood-cuts.)
[Am. Journ. S. and A. (3), X., 395, 396, 1875.]

PHYSIOLOGY.

Cleland (John). Animal Physiology. Wm. Collins, Sons, & Co. 1875. (Advanced Science Series.)
[Nature, XI., 504, 1875.]

Newton (E. Tulley). An Introduction to Animal Physiology. London. 1875.
(Mumby's "Science and Art Department" Series of Text-books.)
[Nature, XII., 474, 1875.]

EMBRYOLOGY.

Foster (Michael) and Francis M. Balfour. The Elements of Embryology. London: Macmillan & Co. 1874.
[Am. Journ. S. and A. (3), IX., 480, 1875.]
[Popular (The) Science Monthly, VII., 242, 1875.]

HISTOLOGY.

Rutherford (William, M.D.). Outlines of Practical Histology. London: J. & A. Churchill. 1875.
[Nature, XII., 433, 434, 1875.]

MISCELLANEOUS.

Buckland (Frank). Log-Book of a Fisherman and Zoologist. Illustrated. London: Chapman & Hall. 1875.
[The Academy, July 17, 1875, pp. 53, 54.]

Ross (Sir James Clark, Commander). The Zoology of the Voyage of H. M. S. "Erebus" and "Terror," under the Command of Captain Sir James Clark Ross, R.N., F.R.S., during the Years 1839 to 1843. By Authority of the Lords Commissioners of the Admiralty. Edited by John Richardson, M.D., F.R.S., etc., and John Edward Gray, Esq., Ph.D., F.R.S., etc. London: . . . Janssen. 1874, 1875.

No. XIX.—Insects (conclusion). By Arthur Gardiner Butler, F.L.S., F.Z.S., etc. 1874.
No. XX.—Crustacea. By Edward J. Miers. 1874.
No. XXI.—Mollusca. By Edgar A. Smith, F.Z.S., etc.
No. XXII.—Birds (conclusion). By R. Bowdler Sharpe, F.L.S., F.Z.S., etc. 1875.
No. XXIII.—Mammalia (conclusion). By John Edward Gray, Ph.D., F.R.S., F.L.S., etc. 1875.
No. XXIV.—Reptiles (conclusion). By Albert Günther, M.A., M.D., Ph.D., F.R.S., V.P.Z.S. 1875.
[Nature, XII., 289, 290, 1875].

SPECIAL GROUPS.

VERTEBRATA.

(*Extinct.*)

Cope (E. D.). The Vertebrata of the Cretaceous Formations of the West. Washington: Government Printing-office. 1875.
(Report of the United States Geological Survey of the Territories, Volume II.)
[Am. Journ. S. and A.]

(*Game Animals.*)

Drummond (Hon. W. H.). The Large Game and Natural History of South and Southeast Africa. From the Journals of the Hon. W. H. Drummond. Edinburgh: Edmonston & Douglas. 1875.
[Nature, XII., 182, 183, 1875.]

Morant (George Francis). Game Preservers and Bird Preservers, which are our Friends? London: Longmans, Green, & Co. 1875.
[The Academy, August 21, 1875, pp. 187, 188.]
[Nature, XII, 395, 1875.]

MAMMALS.

Fayrer (J.). The Royal Tiger of Bengal: his Life and Death. London: J. & A. Churchill. 1875.
[Nature, XII., 474, 1875.]

Markham (A. H.). A Whaling Cruise to Baffin's Bay and the Gulf of Boothia. With an Introduction by Rear-Admiral Osborn, C.B., F.R.S. Second edition. London: Sampson Low & Co. 1875.
[Nature, XI., 404, 405, 1875.]

Williams (H. S.). The Bones, Ligaments, and Muscles of the Domestic Cat. With an Atlas of Photo-lithographic Plates, reduced from those of Straus-Durckheim. New York: G. P. Putnam's Sons. 1875.
[Am. Journ. S. and A. (3), X., 397, 1875.]

MAN.

(General.)

Gerland (Georg). Anthropologische Beiträge. Vol. I. Halle an der Saale: Lippert'sche Buchhandlung. 1875.
[Nature, XI., 384, 385, 1875.]
[The Academy, Nov. 27, 1875, pp. 555, 556.]

Lubbock (Sir John). The Origin of Civilization, and the Primitive Condition of Man: Mental and Social Condition of Savages. Third edition. London: Longmans, Green, & Co. 1875.
[Nature, XI., 401–403, 1875.]

Quatrefages (A. de). The Natural History of Man: a Course of Elementary Lectures. Translated from the French, by Eliza A. Youmans. With an Appendix. New York: D. Appleton and Company. 1875. (12mo, 152 pp.)
[Popular (The) Science Monthly, VII., 117, 1875.]

Southall (James C.). The Recent Origin of Man, illustrated by Geology and the Modern Science of Prehistoric Archæology. Philadelphia: J. B. Lippincott & Co. 1875. (8vo, 606 pp., with many Illustrations.)
[Am. Journ. S. and A. (3), X., 77, 1875.]
[The Academy, Oct. 23, 1875, pp. 431–433.]

(Physiology.)

Hartley (Walter Noel). Air and its Relations to Life, 1774–1874; a Course of Lectures delivered at the Royal Institution of Great Britain in 1874, with some Additions. By Walter Noel Hartley, F.C.S., Demonstrator of Chemistry at King's College, London. London: Longmans & Co. 1875.

Helmholtz (Hermann L. F.). The Sensations of Tone as a Physiological Basis for the Theory of Music. Translated with Additional Notes and an Additional Appendix, by Alexander J. Elliss. London: Longmans & Co. 1875.
[The Academy, 1875, pp. 579, 580, 605, 606.]
[Nature, XII., 449–452, 1875.]

Hermann (D. L.). Elements of Human Physiology. By D. L. Hermann, Professor of Physiology at the University of Zurich. Translated by Arthur Gamgee, M.D., F.R.S. London: Smith, Elder, & Co. 1875.
[Nature, XIII., 22, 23, 1875.]

His (Wilhelm). Unsere Körperform und das physiologische Problem ihrer Enstehung. Briefe an einen befreundeten Naturforscher. Leipzig: Vogel. 1875.
[Nature, XII., 328, 1875.]

Jourdanet (D.). Influence de la pression de l'air sur la vie de l'homme. Paris: Masson. 1874. (2 vols.)
[Nature, XII., 472–474, 1875.]

Küss (Professor). A New Manual of Physiology. Boston: James Campbell. 1875. (12mo, 531 pages. Price, $2 50.)
[Popular (The) Science Monthly, VII., 243, 244, 1875.]

(*Philology.*)

Whitney (William Dwight). The Life and Growth of Language: An Outline of Linguistic Science. By William Dwight Whitney, Professor of Sanskrit and Comparative Philology in Yale College. New York: D. Appleton & Co. 1875. (12mo, vii. 326 pp.)
(International Scientific Series, Vol. XVI.)
[Popular (The) Science Monthly, VII., 368, 369, 1875.]
[The Academy, Sept. 18, 1875, pp. 310, 311.]
[Nature, XII., 225–228, 1875.]

(*Special Ethnology.*)

Europe.

Lartet (Edouard) and Henry Christy. Reliquæ Aquitanicæ; being Contributions to Archæology and Palæontology of Périgord and the adjoining Provinces of Southern France. Edited by Thomás Rupert Jones, F.R.S., F.G.S., etc., Prof. Geol. Roy. Mil. and Staff Colleges, Sandhurst. Part XVI., May, 1875. Pages 225–256 and 183–187. Plate C., ix. and x.
[Am. Journ. S. and A. (3), X., 233, 234.]

North America.

Bancroft (Hubert H.). The Native Races of the Pacific States of North America. In Five Volumes. New York: D. Appleton & Co., 1874–5:

Vol. I.—Wild Tribes; their Manners and Customs.
Vol. II.—Civilized Nations of Mexico and Central America.
Vol. III.—Mythology and Languages of both Savage and Civilized Nations.
Vol. IV.—Antiquities and Architectural Remains.
Vol. V.—Aboriginal History and Migrations: Index to the entire work.
[Nature, XII., 529–530, 1875.]

Rink (Dr. Henry). Tales and Traditions of the Eskimo, with a Sketch of their Habits, Religion, Language, and other Peculiarities. Translated from the Danish by the Author. Edited by Dr. Robert Brown. With numerous Illustrations drawn and engraved by Eskimo. Edinburgh and London: Blackwood & Sons. 1875.
[Nature, XIII., 103–105, 1875.]

BIRDS.

Alix (Edmond). Essai sur l'Appareil Locomoteur des Oiseaux. Paris: G. Masson. 1875.
[Nature, XIII., 3, 4, 1875.]

Coues (Elliott). Birds of the Northwest: A Hand-book of the Ornithology of the Region drained by the Missouri River and its Tributaries. By Elliott Coues, Captain and Assistant Surgeon U. S. Army. Washington: Government Printing-office. 1874. 8vo, xi. p. 791.
(Department of the Interior. United States Geological Survey of the Ter-

ritories. F. V. Hayden, U. S. Geologist in Charge. Miscellaneous publications—No. 3.)

Dresser (H. E.). A History of the Birds of Europe, including all the Species inhabiting the Western Palæarctic Region. [Vol. III.] Published by the Author, by special permission, at the Office of the Zoological Society of London. [1874, 1875.]
[Nature, XI., 485, 486, 1875.]

Flagg (Wilson). The Birds and Seasons of New England. With Illustrations. Boston: James R. Osgood & Co. 1875. (12mo, 457 pp.)
[Nature, XII., 211, 1875.]

Giebel (Dr. G. C.). Thesaurus Ornithologiae. Repertorium der gesammten ornithologischen Literatur und Nomenclator sämmtlicher Gattungen und Arten der Vögel, nebst Synonymen und geographischer Verbreitung. Zweiter Band. [D.-O.] Leipzig: F. A. Brockhaus. 1875. (8vo, vi. v. 401-787 pp.)
(This work has been very severely criticised by ornithologists, and must be consulted and used with extreme caution.)

Gould (John). A Monograph of the Trogonidæ; or, Family of Trogons. Second edition. London: Published by the Author, 1875.
[Nature, XIII., 166, 1875.]
(The first edition was published in 1838; 34 species were recognized in the old edition, 46 have been admitted in the new.)

Harting (J. E.). Our Summer Migrants. An Account of the Migratory Birds which pass the Summer in the British Islands. Illustrated from designs by Thomas Bewick. London: Bickers & Son. 1875.
[The Academy, August 21, 1875, pp. 187, 188.]
[Nature, XII., 249, 250, 1875.]

Heuglin (Theodor von). Ornithologie Nordost-Afrika's, der Nilquellen und Küsten-Gebiete, des Rothen Meeres und des nördlichen Somal-Landes. Cassel: Fischer. 1869-74.
[Nature, XIII., 289, 1876.]

Irby (L. Howard L.). The Ornithology of the Strait of Gibraltar. London: R. H. Porter; Dulan and Co. 1875.
[Nature, XII., 364, 365, 1875.]

Sharpe (R. Bowdler). Catalogue of the Striges, or Nocturnal Birds of Prey, in the Collection of the British Museum. London: Printed by Order of the Trustees. 1875.
(Catalogue of the Birds in the British Museum. Vol. II. London: Printed by Order of the Trustees. 1875. 8vo, xii. 326 pp.; xiv. colored Plates.)

REPTILES AND AMPHIBIANS.

Cope (Edward D.). Check-list of North American Batrachia and Reptilia; with a Systematic List of the Higher Groups, and an Essay on Geographical Distribution. Based on the Specimens contained in the

United States National Museum. Washington: Government Printing-office. 1875.

(Bulletin of the United States National Museum, No. I., 8vo, 2 title-pages, 104 pp.)

FISHES.

Collett (Robert). Norges Fiske, me Bemærkninger om deres Udbredelse. (Hermed 2 Pl. og 1 Kart.) Trykt som Tillægsh. til Vidensk.—Selsk. Forh. f. 1874. Christiania. Trykt hos A. W. Brœgger. 1875. (8vo, title, 240 pp., 2 plates, 1 folded map.)

Ireland. Report of the Inspectors of Irish Fisheries on the Sea and Inland Fisheries of Ireland for 1874. Presented to both Houses of Parliament. Dublin: Alex. Thom. 1875.

[Nature, XII., 392–394, 1875.]

United States. United States Commission of Fish and Fisheries. Part II. Report of the Commissioner for 1872 and 1873, with Supplementary Papers. Washington, D.C. 1874. 8vo, cii. 808 pp., with 37 Plates and 4 Maps.

[Am. Journ. S. and A. (3), IX., 477, 478, 1875.]

MOLLUSKS.

Harting (J. E.). Rambles in Search of Shells. London: John Van Voorst. 1875.

[Nature, XII., 493, 494, 1875.]

Woodward (S. P.). A Manual of Mollusca. Third edition. London: Lockwood and Co. 1875.

[Nature, XII., 494, 1875.]

(This is noticed simply to indicate that there is no real difference between it and the second edition with its appendix.)

INSECTS.

Hunter (John). A Manual of Bee-keeping. By John Hunter, Honorary Secretary of the British Bee-keepers' Association. London: Hardwick. 1875.

[Nature, XII., 395, 1875.]

Pettigrew (A.). The Handy-book of Bees, being a Practical Treatise on their Profitable Management. Second edition, Revised and Improved. Edinburgh and London: Blackwood & Sons. 1875.

[Nature, XII., 395, 1875.]

Riley (Charles V.). Seventh Annual Report on the Noxious, Beneficial, and other Insects of the State of Missouri, made to the State Board of Agriculture. By Charles V. Riley, State Entomologist. St. Louis. 1875. (8vo.)

[Am. Journ. S. and A. (3), X., 69, 70, 1875.]

[Popular (The) Science Monthly, VII., 375, 376, 1875.]

SPIDERS.

Hentz (Nicolas Marcellus). A Collection of the Arachnological Writings of Nicolas Marcellus Hentz, M.D. Edited by Edward Burgess. With Notes and Descriptions by James H. Emerton. Boston. (8vo, 171 pp., 21 pl.)
(Occasional Papers of the Boston Society of Natural History, II.)
[Nature, XIII., 281–283, 1876.]

HELMINTHS.

Lewis (T. R.). The Pathological Significance of Nematode Hæmatozoa. Calcutta. 1874.
[Nature, XI., 363, 1875.]

Sutton (George). A Report on Trichinosis as observed in Dearborn Co., Ind., in 1874. By George Sutton, M.D., Aurora, Ind. (Reprinted from the Transactions of the Indiana State Medical Society, 1875.)
[Nature, XIII., 105, 106, 1875.]

ECHINODERMS.

Lyman (Theodore). Illustrated Catalogue of the Museum of Comparative Zoölogy at Harvard College. No. VIII.: Zoological Results of the Hassler Expedition.

II. Ophiuridæ and Astrophytidæ, including those dredged by the late Dr. Wm. Stimpson. Cambridge. 1875. (Folio; 84 pages; 5 plates; 5 figures printed in the text.)

POLYPS.

Dana (James D.). Corals and Coral Islands. London: Sampson Low & Co. 1875.
[The Academy, August 21, 1875, p. 191.]

BOTANY.

GENERAL.

Systematic.

Brown (Robert). A Manual of Botany, Anatomical and Physiological, for the Use of Students. Edinburgh: Blackwood. 1874.
[Nature, XI., 345–347, 1875.]

Browne (W. J.). Botany for Schools and Science Classes. Belfast: W. Mullan. 1875.
(Elementary Science Manuals.)
[Nature, XIII., 85, 1875.]

Sachs (Julius). Text-book of Botany: Morphological and Physiological. By Julius Sachs, Professor in the University of Würzburg. Trans-

lated and Annotated by Alfred W. Bennett, M.A., and W. J. Thistleton Dyer, M.A. London: Macmillan & Co. 1875. (8vo, 858 pp. Price, $12 50.)
[Am. Journ. S. and A. (3), X., 64, 65, 1875.]
[Popular (The) Science Monthly, VII., 371, 372, 1875.]
[The Academy, Sept. 18, 1875, pp. 309, 310.]

PHYSIOLOGY.

Insectivorous Plants.

Darwin (Charles). Insectivorous Plants. With Illustrations. London: J. Murray. 1875.
[Nature, XII., 206–209, 228–231, 1875.]
[The Academy, July 24, 1875, pp. 93, 94.]

Climbing Plants.

Darwin (Charles). The Movements and Habits of Climbing Plants. Second edition, revised. London: J. Murray. 1875.
[The Academy, Nov. 20, 1875, pp. 530, 531.]
[Nature, XIII., 65, 66, 1875.]

Mutual Relations of Plants and Insects.

Lubbock (Sir John). British Wild Flowers, considered in Relation to Insects. With numerous Illustrations. London: Macmillan & Co. 1875. (12mo, 186 pp.)
[Am. Journ. S. and A. (3), IX., 324–326, 1876.]
[Popular (The) Science Monthly, VII., 623, 624, 1875.]

Periodicity.

Pfeffer (Dr. W.). Die Periodischen Bewegüngen der Blattogane. Von Dr. W. Pfeffer, A.O. Professor in Bonn. Mit 4 lithographirten Tafeln und 9 Holzschnitten. Leipzig: verlag von Wilhelm Engelmann. 1875. (8vo, 176 pp.)
[Nature, XIII., 24, 25, 1875.]

FLORAS.

Geography of Plants.

Baker (J. G.). Elementary Lessons in Botanical Geography. By J. G. Baker, F.L.S., Assistant Curator of the Herbarium at Kew. London: L. Reeve and Co. 1875.
[Nature, XII., 532, 533, 1875.]

Asia.

Hooker (J. D.). The Flora of British India. By J. D. Hooker, C.B., assisted by various Botanists. Vol. I. Ranunculaceæ to Sapindaceæ. London: L. Reeve and Co. 1875.
[Nature, XII., 3–5, 1875.]
[Am. Journ. S. and A. (3), IX., 473, 1875.]

Europe.

Roper (F. C. S.). Flora of Eastbourne. Being an Introduction to the Flowering Plants, Ferns, etc., of the Cuckmere District, East Sussex, with a Map. London: John Van Voorst. (8vo, 165 pp.)
[Nature, XII., 290, 1875.]

DIFFERENT GROUPS.

Phænogamous Trees.

Alphand (A.). Arboretum et Fleuriste de la Ville de Paris. Description, culture, et usage des Arbres, Arbrisseaux, et des Plantes herbacées et frutescentes de plein air, et de serres, employées dans l'ornementation des Parcs et Jardins. Paris: Rothschild. 1875. (Folio, 110 pp.)
[Nature, XII., 25, 1875.]

Bidie (George). Report on the Neilgherry Loranthaceous Parasitical Plants destructive to Exotic Forest and Fruit Trees. Printed by E. Keys, at the Government Press. 1874.
[Nature, XII., 453, 1875.]

Dupont (Adolph E.) et Bouquet de la Grye. Les Bois indigènes et étrangers: Physiologie, Culture, Production, Qualités, Industrie, Commerce. Par Adolphe E. Dupont et Bouquet de la Grye. Paris: Rothschild. 1875.
[Nature, XII., 512, 513, 1875.]

Emerson (George B.). A Report on the Trees and Shrubs growing naturally in the Forests of Massachusetts. Second edition. Boston: Little, Brown, & Co. 1875. (2 vols., 8vo, with many plates.)
[Am. Journ. S. and A. (3), X., 393, 394, 1875.]

Musci.

Sullivant (William S.). Icones Muscorum, or Figures and Descriptions of most of those Mosses peculiar to North America which have not yet been figured. Posthumous Supplement, with 81 Copper-plates. Cambridge: Charles W. Sever. London: Trübner & Co. December, 1874. (Imp. 8vo.)
[Am. Journ. S. and A., (3), IX., 323, 324, 1875.]

Fungi.

Cooke (M. C., M.A., LL.D.). Fungi: their Nature and Uses. By M. C. Cooke, M.A., LL.D. Edited by the Rev. M. J. Berkeley, M.A., F.L.S. New York: D. Appleton & Co. . . . 1875. (12mo, xii. 299 pp., 109 figs.)
(The International Scientific Series. Vol. XV.)
[Am. Journ. S. and A., (3), X., 62, 1875.]
[The Academy, August 14, 1875, pp. 172–174.]
[Popular (The) Science Monthly, VII., 240, 241, 1875.]

GEOLOGY.

GENERAL.

Systematic.

Dana (James D.). The Geological Story briefly told. An Introduction to Geology for the General Reader and for Beginners in the Science. New York and Chicago: Ivison, Blakeman, Taylor, & Co. 1875. (12mo, 264 pp., with numerous Illustrations. Price, $1 50.)
[Am. Journ. S. and A., (3), IX., 471, 1875.]
[Popular (The) Science Monthly, VII., 497, 1875.]

Climate and Time.

Croll (James). Climate and Time in their Geological Relations: a Theory of Secular Changes of the Earth's Climate. London: Daldy, Isbister, & Co. 1875. (8vo, 578 pp., with many Illustrations.)
[Am. Journ. S. and A. (3), X., 78, 1875.]
[Nature, XII., 141–144, 1875.]

Valleys, etc.

Kinahan (G. H.). Valleys and their Relation to Fissures, Fractures, and Faults. London: Trübner & Co. 1875.
[The Academy, August 7, 1875, pp. 147, 148.]
[Nature, XI., 403, 404, 1875.]

EPOCHS.

Coal.

Mietzsch (Dr. Hermann). Geologie in der Kohlenlager. Leipzig. 1875.
[Nature, XIII., 166, 1875.]

COUNTRIES.

Europe.

Whitaker (William). Guide to the Geology of London and the Neighbourhood (Geological Survey of England and Wales). London: Longmans & Co. 1875.
[Nature, XII., 452, 453, 1875.]

North America.

(Dominion of Canada.)

Dawson (G. M.). Report on the Geology and Resources of the Region in the Vicinity of the 49th Parallel from the Lake of the Woods to the Rocky Mountains. By G. M. Dawson, Geologist and Botanist to the Commission. Montreal. 1875. (8vo, 388 pp., with a Colored Geological Map, Views, and Sections.) Addressed to Mayor D. R. Cameron, R.A., H. M. Boundary Commissioner.
[Am. Journ. S. and A. (3), X., 384, 385, 1875.]

(*United States.*)

United States. Department of the Interior: United States Geological and Geographical Survey of the Territories; *First Section:* Annual Report of the United States Geological and Geographical Survey of the Territories, for 1873, embracing Colorado. By F. V. Hayden, United States Geologist. Conducted under the Authority of the Secretary of the Interior. Washington: Government Printing-office. 1874. (Really 1875. 8vo.)

—— —— Bulletin of the United States Geological and Geographical Survey of the Territories. Second Series. Washington: Government Printing-office. 1875.

—— —— Report of the United States Geological Survey of the Territories. F. V. Hayden, United States Geologist, in charge. Volume II. The Vertebrata of the West. By E. D. Cope. Washington: Government Printing-office. 1875. (4to.)

—— *Second Section.* Exploration of the Colorado River of the West and its Tributaries in 1869, 1870, 1871, and 1872. By J. M. Powell. Washington: Government Printing-office. 1875.
[Popular (The) Science Monthly, VIII., 756, 1856.]

Raymond (Rossiter W.). Statistics of Mines and Mining (Sixth Annual Report). Washington. 1874. (8vo, 585 pp.)
[Am. Journ. S. and A. (3), X., 392, 1875.]

(*Individual States.*)

Alabama. Geological Survey of Alabama. Report of Progress for 1874. By Eugene A. Smith, Ph.D., State Geologist. Montgomery, Alabama. 1875. (8vo, 140 pp.)
[Am. Journ. S. and A. (3), IX., 400, 401, 1875.]
[Popular (The) Science Monthly, VII., 626, 1876.]

Georgia: *Geological Survey.* Report of Progress of the Mineralogical, Geological, and Physical Survey of the State of Georgia, for the period from Sept. 1 to Dec. 31, 1874. By George Little, State Geologist. Augusta. 1875.
[Am. Journ. S. and A. (3), X., 60, 1875.]

Indiana. Sixth Annual Report of the Geological Survey of Indiana, made during the year 1874. By E. T. Cox, State Geologist; assisted by Prof. John Collett, Prof. W. W. Borden, and Dr. G. M. Levette. (8vo, 288 pp., with Maps and Plates.)
[Am. Journ. S. and A. (3), 305, 306, 1875.]

Minnesota. The Geological and Natural History Survey of Minnesota. The Third Annual Report, for the year 1874. By H. H. Winchell, State Geologist. Submitted to the President of the University of Minnesota, Dec. 31, 1874.
[Am. Journ. S. and A. (3), X., 306, 307, 1875.]

Ohio. Report of the Geological Survey of Ohio. Volume II. Geology and Palaeontology. Part I. Geology. Officers of the Survey: J. S. Newberry, Chief Geologist; E. B. Andrews, and Edward Orton, Assistant Geologists; F. G. Wormley, Chemist; F. B. Meek, Palaeontologist. Published by Authority of the Legislature of Ohio. Columbus, Ohio. (8vo, 702 pp., with Plates, Wood-cuts, and Colored Geological County Maps.)
[Am. Journ. S. and A. (3), X., 304, 305, 1875.]

Oregon. Preliminary Report of the State Geologist of Oregon, Rev. Thomas Condon. Salem, Oregon. 1874. (8vo, 22 pp.)
[Am. Journ. S. and A. (3), IX., 401, 1875.]

Pennsylvania. Second Geological Survey of Pennsylvania, 1874. Report "B." Preliminary Report on the Mineralogy of Pennsylvania. By F. A. Genth. With an Appendix on the Hydro-carbon Compounds, by Samuel P. Sadtler. Harrisburg. 1875. (8vo, 206 pp.)
[Am. Journ. S. and A. (3), X., 59, 1875.]
[Popular (The) Science Monthly, VII., 754.]

——— ——— Report "J." On the Petroleum of Pennsylvania. By Henry E. Wrigley. With a Map and Profile of a Line of Levels through Butler, Armstrong, and Clarion Counties, by D. J. Lucas; also a similar profile along Slippery Rock Creek, by J. P. Lesley. Harrisburg. 1875. (8vo, 122 pp.)
[Am. Journ. S. and A. (3), X., 59, 1875.]

GEOGRAPHY.

[In this section are included only those works which treat more especially of the topographical features of comparatively little-known countries.]

GENERAL.

Michelet (Jules). The Sea. London and Edinburgh: Nelson and Sons. 1875.
[Nature, XIII., 106, 1875.]

Jahresbericht der Commission zur wissenschaftlichen Untersuchung der deutschen Meere in Kiel, für dei Jahre 1872, 1873, II. und III. Jahrgang. Berlin. 1875. (Large 4to, with 12 Plates and a Chart.)
[Am. Journ. S. and A. (3), IX., 479, 1875.]

ARCTIC REGIONS.

London (Royal Geographical Society of). A Selection of Papers on Arctic Geography and Ethnology, reprinted and presented to the Arctic Expedition of 1875, by the President, Council, and Fellows of the Royal Geographical Society. London: John Murray. 1875. (8vo.)
[The Academy, July 3, 1875, pp. 1, 2.]

AFRICA.

Melliss (John Charles). St. Helena: a Physical, Historical, and

Topographical Description of the Island, including its Geology, Fauna, Flora, and Meteorology. London: L. Reeve. 1875.
[Nature, XI., 501–503, 1875.]

Mohr (Edouard). Nach den Victoriafällen des Zambesi. Leipzig: Hirt und Sohn. 1875. (2 vols., 8vo.)
[Nature, XII., 231, 1875.]

Monteiro (Joachim John). Angola and the River Congo. (2 vols., with Map and Illustrations.) London: Macmillan & Co. 1875.
[Nature, XIII., 161–164, 1875.]

Schweinfurth (Dr. Georg). The Heart of Africa: Three Years' Travels and Adventures in the Unexplored Regions of Central Africa, from 1868 to 1871. In Two Volumes. New York: Harper & Brothers. (Price, $8 00.)
[Popular (The) Science Monthly, VII., 237–240, 1875.]

Southworth (Alvan S.). Four Thousand Miles of African Travel: a Personal Record of a Journey up the Nile and through the Soudan to the Confines of Central Africa. By Alvan S. Southworth, Secretary of the American Geographical Society. New York: Baker, Pratt, & Co. 1875.
[Nature, XIII., 43–45, 1875.]

ASIA.

Drew (Frederick). The Jummoo and Kashmir Territories. A Geographical Account. London: Stanford. 1875.
[Nature, XII., 550–552, 1875.]

Wilson (Andrew). The Abode of Snow. Observations on a Journey from Chinese Tibet to the Indian Caucasus, through the Upper Valleys of the Himalayas. Edinburgh and London: W. Blackwood & Co. 1875.
[Nature, XIII., 4, 5, 1875.]

EUROPE.

Watts (William Lord). Snioland; or, Iceland, its Jökulls and Fjalls. London: Longmans & Co. 1875.
[Nature, XII., 453, 1875.]

NORTH AMERICA.

Dixon (William Hepworth). White Conquest. Two Vols. London: Chatto and Windus. 1876.
[Nature, XIII., 23, 24, 1875.]

Pinart (Alph. L.). Voyages à la Cote Nord-Ouest de l'Amérique exécuté durant les Années, 1870–72. Vol. I., Partie I. Histoire Naturelle. Paris. 1875. (4to, 51 pp., with Plates, A to E.)
[Am. Journ. S. and A. (3), X., 400, 1875.]

Jones (Wm. A.). Report upon the Reconnaissance of Northwestern Wyoming, including Yellowstone National Park, made in the Summer of

1873; by Wm. A. Jones, Captain of Engineers, U.S.A. Washington: Government Printing Office. 1875. (8vo, 326 pp., with numerous Maps.)
[Am. Journ. S. and A. (3), X., 59, 1875.]

Powell (Professor J. W.). Exploration of the Colorado River of the West and its Tributaries, explored in 1869 to 1872 under the Direction of the Secretary of the Smithsonian Institution. By Prof. J. W. Powell. Washington: Government Printing-office. 1875. (4to, 292 pp., with many Plates, 8 Maps.)
[Am. Journ. S. and A. (3), X., 303, 304, 1875.]

POLYNESIA AND AUSTRALASIA.

Bird (Isabella J.). The Hawaiian Archipelago. Six Months among the Palm Groves, Coral Reefs, and Volcanoes of the Sandwich Islands. With Illustrations. London: J. Murray. 1875.
[Nature, XI., 322–324, 1875.]

De Ricci (J. H.). Fiji; our New Province in the South Seas. With Two Maps. London: Stanford. 1875.
[Nature, XII., 5, 1875.]

Forrest (John). Explorations in Australia: I. Explorations in Search of Dr. Leichardt and Party. II. From Perth to Adelaide, around the Great Australian Bight. III. From Champion Bay across the Desert to the Telegraph and Adelaide. London: Sampson Low, Marston, Low, & Searle. 1875.
[The Academy, Dec. 11, 1875, pp. 595, 596.]

Forrest (John). Explorations in Australia; with an Appendix on the Condition of Western Australia. London: Sampson Low & Co. 1875.
[Nature, XIII., 83–85, 1875.]

Mundy (D. L.). Rotomahana and the Boiling Springs of New Zealand. A Photographic Series of Sixteen Views. With Descriptive Notes by Ferdinand von Hochstetter, Professor of the Polytechnic Institution of Vienna. London: Sampson Low & Co. 1875.
[Nature, XII., 532, 1875.]

R. INDEX TO THE REFERENCES.

In the large number of serial works received regularly for use in the preparation of material for the *Record*, it has been found expedient to adopt some mode of abbreviating the titles, so as to save both time and space in writing and printing them. For this purpose the different countries have been represented by letters, and the journals numbered as in the following table. Publications referred to only occasionally are indicated by abbreviations of their titles at the ends of the articles. Where no references are made, it is to be understood that the article is partially or entirely original, and prepared by the editor or his collaborators; in some cases, however, that the quotation has been mislaid or overlooked.

The list of works here mentioned relates simply to those most frequently consulted—especially those coming direct through the post-office—and forms but a small portion of those passed regularly in review. The Smithsonian Institution is in regular and constant receipt of the latest publications from at least one thousand societies and establishments, public and private, in different parts of the world, and its unrivaled scientific library is used to a greater or less extent by the editor and his associates in the preparation of the *Annual Record*.

A. *Great Britain.*

1. The Chemical News and Journal of Physical Science. Weekly. London.
2. Land and Water. Hunting, Shooting, Fishing, practical Natural History. Weekly. London.
3. Iron: the Journal of Science, Metals, and Manufactures: with which is incorporated the Mechanics' Magazine, established 1823. Weekly. London.
4. Hardwicke's Science Gossip. Monthly. London.
5. The Popular Science Review. Quarterly. London.
6. The Geographical Magazine (late Ocean Highways). Monthly. London.
7. London, Edinburgh, and Dublin Philosophical Magazine. Monthly. London.
8. Scientific Review: Record of progress in Arts, Industry, and Manufactures; and Journal of the Inventors' Institute. Monthly. London.

10. The Annals and Magazine of Natural History. Monthly. London.

11. Proceedings of the Scientific Meetings of the Zoological Society of London. London.

12. Nature: a weekly illustrated Journal of Science. London.

13. The Academy: a weekly review of Literature, Science, and Art. London.

14. The Pharmaceutical Journal and Transactions of the Pharmaceutical Society. Weekly. London.

15. The Athenæum: Journal of English and Foreign Literature, Science, and Fine Arts, Music, and the Drama. Weekly. London.

16. The Quarterly Journal of Science, and Annals of Mining, Metallurgy, Engineering, Industrial Arts, Manufactures, and Technology. London.

17. The Journal of Applied Science: a monthly record of progress in the Industrial Arts. London.

18. English Mechanic and World of Science. With which are incorporated "The Mechanic," "Scientific Opinion," and the "British and Foreign Mechanic." Weekly. London.

19. The Field, the Farm, the Garden: the Country Gentleman's Newspaper. Folio. Weekly. London.

20. Medical Times and Gazette. Weekly. London.

21. Journal of the Chemical Society, containing the papers read before the Society, and abstracts of chemical papers published in other journals. Monthly. London.

22. Illustrated London News. Weekly. London.

23. Journal of the Society of Arts. Weekly. London.

24. The Telegraphic Journal, and Electrical Review. Weekly. London.

25. The Electrical News and Telegraphic Reporter. Weekly. London.

B. *France.*

1. Bulletin hebdomadaire de l'Association Scientifique de France. Weekly. Paris.

3. Les Mondes: revue hebdomadaire des Sciences et de leurs applications aux Arts et a l'Industrie. Weekly. Paris.

4. Le Moniteur Scientifique du Dr. Quesneville. Journal des Sciences pures et appliquées. Bi-monthly. Paris.

5. Le Technologiste, ou Archives des progrés de l'industrie française et étrangère. Monthly. Paris.

6. Comptes rendus hebdomadaires des séances de l'Académie des Sciences. Weekly. Paris.

8. Revue Scientifique. Weekly. Paris.

9. Revue hebdomadaire de Chimie scientifique et industrielle publiée sous la direction M. Ch. Mène. Weekly. Paris.

10. Bulletin Mensuel de la Société d'Acclimatation. Monthly. Paris.

11. Revue de Therapeutique Medico-chirurgicale. Bi-monthly. Paris.

12. Bulletin général de Therapeutique médicale et chirurgicale. Bi-monthly. Paris.

13. La Nature. Weekly. Paris.

14. Journal de Zoologie. Paul Gervais. Bi-monthly. Paris.

15. Annales des Sciences Naturelles: zoologie et paléontologie. Milne-Edwards. Occasional. Paris.

16. Revue et Magasin de Zoologie pure et appliquée. Monthly. Paris.

17. Archives de Zoologie experimentale et générale. H. Lacaze-Duthiers. Quarterly. Paris.

18. Annales des Sciences geologiques. Hébert and Alphonse Milne-Edwards. Occasional. Paris.

19. La Chasse Illustrée. A. Didot. Weekly. Paris.

20. Materiaux pour l'histoire primitive et naturelle de l'homme. Monthly. Octavo. Toulouse.

21. Revue d'Anthropologie de M. Paul Broca. Quarterly. Octavo. Paris.

C. *Germany and Austria.*

1. Aus der Natur. Die neuesten Entdeckungen auf dem Gebiete der Naturwissenschaften. Weekly. Leipsic.

2. Archiv der Pharmacie. Monthly. Halle.

3. Das Ausland. Ueberschau der neuesten Forschungen auf dem Gebiete der Natur- Erd- und Völkerkunde. Weekly. Augsburg.

4. Badische Gewerbezeitung für Haus und Familie. Monthly. Karlsruhe.

5. Deutsche illustrirte Gewerbezeitung. Weekly. Berlin.

6. Deutsche Industrie-Zeitung: Organ der Handels- und Gewerbekammern zu Chemnitz, etc. Weekly. Dresden.

7. Gaea. Natur und Leben. Zeitschrift zur Verbreitung und Hebung naturwissenschaftlicher, geographischer, und technischer Kenntnisse. Monthly. Köln and Leipsic.

8. Industrie-Blätter: Wochenschrift für Fortschritt und Aufklärung in Gewerbe, Hauswirthschaft, Gesundheitspflege, etc. Weekly. Berlin.

9. Kurze Berichte über die neuesten Erfindungen, Entdeckungen und Verbesserungen im Gebiete des Gewerbwesens, des Handels und der Landwirthschaft. Monthly. Mannheim.

10. Landwirthschaft und Industrie; Monatsschrift für Landwirthe, Fabrikanten und Geschäftsleute jeder Art. Monthly. Berlin.

11. Die neuesten Erfindungen im Gebiete der Landwirthschaft, des Bergbaues, des Fabrik und Gewerbwesens und des Handels. Illustrirte Zeitschrift. Semi-monthly. Vienna.

12. Oberlausitzer Gewerbeblatt. Organ der Gewerbe- und Handwerker-Vereine des Königreichs Sachsen. Semi-monthly. Bautzen.

13. Polytechnisches Central-Blatt. Semi-monthly. Leipsic.

14. Polytechnisches Journal, etc. Dr. E. M. Dingler. Semi-monthly. Augsburg.

15. Polytechnisches Notizblatt für Gewerbtreibende Fabrikanten und Künstler. Bi-monthly. Mainz.

16. Blätter für Gewerbe, Technik, und Industrie. Leipsic.

17. Mittheilungen aus Justus Perthes geographischer Anstalt über wichtige neue Erforschungen auf dem Gesammtgebiete der Geographie. Dr. A. Petermann. Monthly. Gotha.

18. Chemisches Central-Blatt. Repertorium für reine, pharmaceutische, physiologische, und technische Chemie. Weekly. Leipsic.

19. Der Naturforscher. Wochenblatt zur Verbreitung der Fortschritte in den Naturwissenschaften. Weekly. Berlin.

21. Neues Jahrbuch für Pharmacie. Monthly. Heidelberg.

22. Landwirthschaftliches Central-Blatt für Deutschland. Monthly. Berlin.

23. Das Deutsche Wollen-Gewerbe. Organ für die Wollen-Waaren-Industrie, etc. Weekly. Grünberg.

24. Färber-Zeitung. Organ für Färberei, Druckerei, Bleicherei, Appretur, etc. Dr. N. Reimann. Weekly. Berlin.

25. Muster-Zeitung. Zeitschrift für Färberei, Druckerei, Bleicherei, Appretur, etc. Dr. F. Springmühl. Weekly. Berlin.

26. Deutsche Färber-Zeitung. J. C. H. Geyer. Bi-monthly. Mühlhausen.

27. Preussisches Handelsarchiv. Wochenschrift für Handel, Gewerbe und Verkehrs-Anstalten. Weekly. Berlin.

28. Central-Blatt für Agrikulturchemie und rationellen Wirthschaftsbetrieb. Monthly. Leipsic.

29. Bayerisches Industrie und Gewerbeblatt. Monthly. Munich.

30. Correspondenz-Blatt der deutschen Gesellschaft für Anthropologie, Ethnologie, und Urgeschichte. Monthly. Braunschweig.

31. Mittheilungen der Anthropologischen Gesellschaft in Wien. 8vo. Vienna.

32. Allgemeine deutsche Polytechnische Zeitung. Herausgegeben von Dr. H. Grothe. Weekly. Berlin.

33. Annalen der Chemie und Pharmacie. Herausgegeben von F. Wöhler, J. Liebig, H. Kopp, E. Erlenmeyer, J. Volhard. Monthly. Leipsic and Heidelberg.

34. Neue deutsche Gewerbe-Zeitung. Bi-monthly. Leipsic.

35. Berichte der deutschen chemischen Gesellschaft zu Berlin. About Monthly. Berlin.

36. Zeitschrift für Wissenschaftliche Zoologie. Siebold & Kölliker. Occasional. Leipsic.

37. Repertorium der Naturwissenschaften. Monatliche Uebersicht der neuesten Arbeiten auf dem Gebiete der Naturwissenschaften. Monthly. Berlin.

D. *America.*

1. Journal of the Franklin Institute, devoted to Science and the Mechanic Arts. Monthly. Philadelphia.

2. Proceedings of the Academy of Natural Sciences of Philadelphia. Monthly. Philadelphia.

3. Proceedings of the Boston Society of Natural History. Quarterly. Boston.

4. The American Journal of Science and Art. Silliman and Dana. Monthly. New Haven, Ct.

5. The American Naturalist: a popular illustrated Magazine of Natural History. Monthly. Salem, Mass.

6. Scientific American: a weekly journal of practical information in Art, Science, Mechanics, Chemistry, and Manufactures. New York.

7. The American Chemist. Monthly. New York.

8. Journal of Applied Chemistry. Monthly. New York.

10. The Rod and Gun: late American Sportsman. Weekly. West Meriden, Ct., and New York.
11. Forest and Stream. Weekly. New York.
12. The Spirit of the Times. Weekly. New York.
13. The Popular Science Monthly. New York.
15. Turf, Field, and Farm. Weekly. New York.
16. Field and Stream. Weekly. Chicago.
17. The Engineering and Mining Journal. Weekly. New York.
18. Live Stock Journal. Monthly. New York and Buffalo.
19. The Poultry World. Monthly. Hartford.
20. The Iron Age. Weekly. New York.
21. The Railroad Gazette. Weekly. New York.
22. The Metal Worker. Weekly. New York.

E. *Netherlands.*

1. Archives néerlandaises des Sciences exactes et naturelles publiées par la Société hollandaise des Sciences a Harlem. Occasionally. La Haye.

F. *Switzerland.*

1. Bibliothèque Universelle et Revue Suisse. Archives des Sciences physiques et naturelles. Monthly. 8vo. Geneva.

G. *Italy.*

1. Rivista Scientifico-industriale compilata da Guido Vimercati. Monthly. 8vo. Florence.

H. *Denmark.*

1. Tidsskrift for Fiskeri. Semi-annual. Copenhagen.

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